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Nova Scotian Institute of Science

HALIFAX, NOVA SCOTIA

VOLUME XXII, PARTS 1-2-3-4.

SESSIONS 1946-1950

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CONTENTS

Vol. XXII, 1946-1950.

1946-1947

Pryophytes and Lichens in the Pastures of the Maritime Provinces. Eville Gorham 1
Presidential Address. F. Ronald Hayes 11
Proceedings of Meetings. Session of 1946-47 14
Abstracts. (Papers read before the Institute but not published in the Proceedings) 18

1947-1948

Fresh Water Algae of the Maritime Provinces. Elywn O. Hughes ... 1
Tetrastichus Minutus Howard, (Hymenoptera; Eulophidea), Reared from the Lady Beetle, Adalia Bipunctata L. W. W. Judd 64
Presidential Address. C. C. Coffin 68
Proceedings of Meetings. Session 1947-48 70
Abstracts. (Papers read before the Institute but not published in the Proceedings) 74

1948-1949

Dedication to Dr. Ernest Hess iii
Faulting in the Vicinity of Halifax, Nova Scotia, H. L. Cameron ... 1
New Records for the Distribution of Certain Land Mollusca in Nova Scotia. Muriel J. Ord and Anne H. G. Watts 16
Presidential Address. C. C. Coffin 36
Proceedings of Meetings. Session 1948-49 38
Abstracts. (Papers read before the Institute but not published in the Proceedings) 42

1949-1950

Hymenoptera and an Inquiline Moth Reared from the Goldenrod Galls Caused by *Gnorimoschema Gallaesolidaginis* Riley, (Lepidoptera) W. W. Judd 1
Spongilla Novae Terrae Potts; A Fresh Water Sponge New to Nova Scotia. Muriel J. Ord and Anne H. G. Watts 8
A New Record for the Mastodon, *Mastodon Americanus* Kerr, from Nova Scotia. Daniel Livingstone 15

CONTENTS

An Increasing Atlantic Influence in Hudson Bay. W. H. Bailey and H. B. Hachey 17
The Vertical Temperature Structure of the Labrador Current. W. B. Bailey and H. B. Hachey 34
Presidential Address. C. B. Weld 49
Proceedings of Meetings. Session of 1949-50 54
Abstracts. (Papers read before the Institute but not published in the Proceedings) 58

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JUN -7 1948
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PROCEEDINGS

OF THE

Nova Scotian Institute of Science

HALIFAX, NOVA SCOTIA

VOL. XXII. 1946-47 PART 1

CONTENTS

Bryophytes and Lichens in the Pastures of the Maritime Provinces. Eville Gorham 1

Presidential Address. F. Ronald Hayes 11

Proceedings of Meetings. Session 1946-47 14

Abstracts. (Papers read before the Institute but not published in the Proceedings) 18

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PROCEEDINGS

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SESSION OF 1946-47

(Vol. XXII, Part 1)

BRYOPHYTES AND LICHENS IN THE PASTURES OF THE MARITIME PROVINCES*

EVILLE GORHAM

Division of Botany, Science Service

Dominion Department of Agriculture

(Received for Publication: May 23, 1947)

ABSTRACT

A list is given of 26 species of mosses, lichens and hepatics found in the pastures of the Maritime Provinces of Canada, which in general are characterized by a high degree of moss cover. The total moss cover is greatest on soils with extreme drainage, either high or low. The dominant cryptogams are the mosses *Hypnum arcuatum*, *Atrichum undulatum* and *Polytrichum commune*. *Hypnum arcuatum* and *Atrichum undulatum* predominate on most soils, the former being especially plentiful in poorly drained pastures. *Polytrichum commune* dominates on highly drained soils; lichens and *Brachythecium salebrosum* being present there in larger quantities than elsewhere. Fertilization readily reduces moss cover.

Two of the most important phases of agriculture in the Maritime Provinces of Canada are those of dairying and stock raising. Both depend for their success on good pastureage. The pastures of the Maritimes are characterized by a high proportion of mosses, and some farmers and agricultural workers have thought that if these plants which do not provide forage were eliminated, the forage species might thereby be increased.

*Contribution No. 891 from the Division of Botany and Plant Pathology, Science Service, Dominion Department of Agriculture, Ottawa, Canada.

When a survey of pastures in the Maritime Provinces was undertaken in the summer of 1945 the mosses, lichens and hepatics found growing on the soil of 97 pastures were identified, and counts made for 72 fields as follows:

Fredericton, N. B.	26 fields	Truro, N. S.	1 field
Petitcodiac, N. B.	2 "	New Glasgow, N. S.	19 fields
Newcastle, N. B.	3 "	Millview, P. E. I.	1 field
Caraquet, N. B.	6 "	Montague, P. E. I.	4 fields
Kedgewick, N. B.	1 field	Charlottetown, P. E. I.	4 "
Woodstock, N. B.	5 fields		

Only established permanent pastures with stable swards were examined. New fields which had not had time to develop a natural flora under the combined influences of climate and grazing were excluded. Only the grazed sward was studied in these surveys, the extensive hummocks, frost-heaved areas and sloughs to be found in many Maritime pastures being disregarded. This treatment excludes *Sphagnum*, found in boggy hollows in many fields, from the list of mosses. It also results in a lower percentage figure for *Polytrichum commune* and *Cladonia* spp., these being often the dominant plants of hummocks.

In the course of the survey each species met with was identified, and the percentage cover of each estimated. Notes were also made on drainage and soil type. Small quadrat frames with an inside area of 60 square inches were placed at random over the grazed sward. Usually 5 or 10 frames were used for each field, the area selected for survey being generally less than 1 acre. The percentage of ground covered by each species was then estimated for each quadrat. The analysis is a subjective one, but in respect to moss cover is probably reasonably accurate, since these plants form mats and do not branch out above as do forage species. Cover estimation is therefore rendered much easier than is the case with grasses. The chief error lies probably in the lack of uniformity throughout each field. This in turn is due to the

numerous variations in micro-topography, and to the tendency of the species to form mats rather than be distributed evenly over the sward.

The number of species found in each pasture ranges from 0 to 9, averaging 3. Cover may go as high as 80%, and averages 28%. The following is a list of the 26 species found in the course of this survey.

Lichens

Peltigera polydactyla (Neck.) Hoffm.
Baeomyces roseus Pers.
Cladonia rangiferina (L.) Web.
Cladonia cristatella Tuck.
Cladonia pyxidata (L.) Hoffm.

Hepatics

Ptilidium pulcherrimum (Web.) Hampe.
Radula (2 spp.)

Mosses

Ceratodon purpureus (Hedw.) Brid.
Ditrichum pusillum (Hedw.) E. G. Britton.
Dicranella rufescens (Dicks., Sm.) Schimp.
Dicranum scoparium (L.) Hedw.
Atrichum undulatum (Hedw.) Beauv.
Polytrichum commune L.
Aulacomnium palustre (Web. & Mohr.) Schwaegr.
Philonotis fontana Brid.
Bryum caespiticium L.
Climacium dendroides (L.) Web. & Mohr.
Brachythecium salebrosum (Hoffm.) Br. & Sch.
Leptodictyum riparium (L., Hedw.) Warnst.
Calliergonella Schreberi (Willd., Br. & Sch.) Grout
Calliergonella cuspidata (L., Brid.) Warnst.
Drepanocladus aduncus (Hedw.) Warnst.
Rhytidiadelphus triquetrus (L., Hedw.) Warnst.
Hypnum arcuatum Lindb.
Thuidium delicatulum (L., Hedw.) Mitt.

Certain other species have also been reported as occurring in pastures in the Maritimes. Roland (1946) states that *Polytrichum piliferum* and *Cladonia* spp. may become common in pastured wire birch-pine woods on the sandy soils of the Annapolis Valley. From the area around Windsor, N. S., Habeeb (1946) records an association of *Astomum Muhlenbergianum*, *Phascum cuspidatum* and *Weisia microstoma* in sterile pastures, sometimes accompanied by *Pottia truncata*.

The predominating species as determined during this survey are *Hypnum arcuatum*, *Atrichum undulatum* and *Polytrichum commune*. The data are not sufficient to indicate a relation of any species to particular parts of the region studied. *Polytrichum* was most frequent in the Caraquet area, being very plentiful on some well drained sands. Elsewhere *Hypnum* and *Atrichum* were generally dominant. The following table indicates the relative abundance of the different species.

TABLE I

PER CENT ABUNDANCE OF IMPORTANT SPECIES

Species	Frequency	Average Cover	Average Cover Where Present	Surveys Exceeding 10%
Hypnum	70	12	17	39
Atrichum	57	5	8	18
Polytrichum	47	4	8	11
Brachythecium	21	1	6	7
Aulacomnium	15	X	+	–
Climacium	15	X	+	–
Thuidium	13	X	+	–
Ceratodon	11	X	5	–
Leptodictyum	11	X	5	–
Cladonia pyxidata	10	X	+	–
Bryum	8	X	+	–
Calliergonella Schreberi	8	X	+	–
Rhytidiadelphus	6	X	6	–
Cladonia rangiferina	6	X	10	–
Others	+	X	+	–

+ =less than 5%
X = " " 1%
– = " " 3%

It must be emphasized that a study of the ecology of these species would entail work on a wide variety of micro-habitats such as sloughs, hummocks, frost-heaved areas, etc. All may be found in a single pasture, therefore the conclusions which may be drawn from data on the grazed sward of whole fields are rather limited. Some observations have been made, however, and are presented in Table II and Table III.

TABLE II. RELATION OF SPECIES TO DRAINAGE

Species	% Cover			
	Drainage High	Good	Fair	Poor
	(10 fields)	(18 fields)	(25 fields)	(19 fields)
Hypnum	3	7	8	29
Atrichum	2	4	6	4
Polytrichum	26	+	3	+
Brachythecium	3	2	+	+
Cladonia rangiferina	4	–	–	+
Cladonia pyxidata	3	–	–	+
Aulacomnium	+	+	+	1
Ceratodon	+	+	1	+
Leptodictyum	+	+	1	+
Drepanocladus	–	–	–	3
Total	41	13	19	37

TABLE III. RELATION OF SPECIES TO SOIL TYPE

Species	% Cover				
	Sand	Sandy Loam	Silt Loam	Silt	Clay Loam
	(14 fields)	(28 fields)	(18 fields)	(3 fields)	(3 fields)
Hypnum	11	11	14	29	24
Atrichum	6	3	7	+	+
Polytrichum	16	3	2	−	2
Brachythecium	2	+	2	2	−
Cladonia rangiferina	2	+	+	−	−
Leptodictyum	+	+	+	+	7
Rhytidiadelphus	−	+	−	−	5
Total	37	17	25	31	38

+ = Less than 1%
− = Absent

It is clear that on the sandy highly-drained soils *Polytrichum* is dominant, and lichens reach their greatest abundance. These plants are often associated with hawkweed (*Hieracium Pilosella*) and poverty grass (*Danthonia spicata*), the lichens being most plentiful where the sward has been opened by frost heaving or other causes. *Brachythecium* is also most abundant on the drier soils. On most soils *Hypnum* and *Atrichum* predominate, the former becoming very plentiful on soils with poor drainage, such as silts and clay loams. *Drepanocladus* was found only once, but was there abundantly on a continually saturated peaty muck. The total moss cover is greatest on those soils with extreme drainage, either high or low, such as sand and clay loam. The average number of species present is three for each drainage class.

Most of the moss species were sterile; *Ceratodon*, *Bryum* and *Polytrichum* being the only ones among the more common

species frequently observed fruiting. In most cases the mosses form dense mats, especially where abundant. A creeping, intertwining type is formed by the pleurocarpous species; a cushion-like mass of upright stems by the acrocarpous forms. An extreme example of the latter type of growth is the *Polytrichum* hummock described by Dore (1940). Nichols (1918) states that the carpets of *Polytrichum* found in old pastures are ideal seed beds for white spruce (*Picea glauca*); where this moss is absent, invading spruce seedlings are much scarcer. The same author claims that as the transition from pasture to woodland takes place, *Polytrichum* is replaced by *Calliergonella Schreberi*.

The economic significance of moss in pastures is not clear. Fertilization will markedly reduce the moss cover, as may be seen from Tables IV, V and VI.

TABLE IV. PASTURE PLOTS, KENTVILLE, N. S.

UNDER TREATMENT FOR 14 YEARS

Plot No.	Treatment (per acre)	% Basal Cover			
		Bare Ground	Mosses	Forage Grasses	White Clover
1	600 lb. superphosphate every 3 years..... 100 lb. potash every 3 years. 100 lb. nitrate of soda annually.....	11	3	48	34
2	Untreated control plot.....	11	36	28	2
3	600 lb. superphosphate every 3 years.....	21	4	50	15

TABLE V. PASTURE PLOTS, KENTVILLE, N. S.

UNDER TREATMENT FOR 5 YEARS

Plot No.	Treatment (per acre)	% Basal Cover			
		Bare Ground	Mosses	Forage Grasses	White Clover
6	600 lb. superphosphate every 3 years 100 lb. potash every 3 years. 300 lb. nitrate of soda annually	31	1	57	8
7	600 lb. superphosphate annually 100 lb. potash annually 300 lb. nitrate of soda annually	24	+	55	16

TABLE VI. PASTURE PLOTS, FREDERICTON, N. B.

Plot No.	Treatment	% Basal Cover			
		Bare Ground	Mosses	Forage Grasses	White Clover
6a	Untreated control plot	3	55	19	7
6b	Lime only	15	32	29	10

At Kentville the use of fertilizer has resulted in a much greater cover and more luxuriant growth of the forage grasses and white clover than in the untreated control plot. There is a marked decrease of mosses and an increase in bare ground. The latter is probably due to the fact that grasses branch out both above and below ground, so that if they are replacing the moss, then their basal cover will not be as great as that of the mosses. A similar picture was obtained at Frederic-

ton, and a single fertilized field at Truro was found to have less than 1% of moss species. A comparison at Fredericton of limed and unlimed fields indicates that such treatment decreases moss cover, increases forage species and bare ground, but has less effect than fertilizers.

There remains the problem of how the fertilizer acts in eliminating the mosses. Beaumont (1932) finds that in New England the presence of *Polytrichum commune* is inversely proportional to the amount of available nutrients in the soil Using sodium nitrate as a soil treatment he reports that the moss is killed in proportion to the amount of nitrate applied. He further states that the action is immediate, and not due to subsequent overcrowding by other plants. A toxic effect might be expected, since mosses are superficial and lack the deep root systems of grasses. However, it is possible that there is also an indirect effect operating in the case of fertilization, at least to prevent reinfestation. The luxuriant growth of grasses and clover in fertilized fields results in a good deal of shading, not found in closely grazed infertile pastures. Accumulation of organic debris is also accelerated. These factors may perhaps be sufficiently deleterious to reduce or prevent high moss cover. They have previously been suggested by Summerhayes (1941) to account for a decrease of mosses following enclosure of vole-grazed grass plots.

It would seem that rather than being harmful, an abundance of mosses in pastures merely indicates extreme drainage conditions, and possibly a low level of fertility. In the case of the poorer dry pastures it may be an important factor in holding the particles of the surface soil together, and in retarding runoff. In dry weather mosses are not strong competitors for available water, since they lack deep root systems.

ACKNOWLEDGMENTS

This study was begun at the suggestion of Professor W. G. Dore, Dalhousie University, Halifax, N. S., whose assistance has been most freely given throughout. Miss Margaret S. Brown and Dr. A. E. Roland, Provincial Botanist, Truro, N. S., very kindly identified certain specimens. Thanks are also due to the superintendents of the Kentville and Fredericton Experimental Stations for their co-operation.

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PRESIDENTIAL ADDRESS

F. Ronald Hayes

(Read October 21, 1946)

This occasion marks the beginning of the 85th annual session. It is my privilege to present a brief review of the Institute's year.

My first duty is to record the death of two of our members. The Institute mourns the loss, aged 76, of Dr. Albert G. Nicholls, a member since 1915, and active in various offices, including that of First Vice-President, until his departure from Halifax in 1929. A native of England, he came to Canada while young and graduated in medicine from McGill University. After post-graduate work on the Continent he came to Halifax as Professor of Pathology at Dalhousie. On leaving Halifax he became editor of the *Journal of the Canadian Medical Association*. He was a man of wide literary as well as scientific interests and contributed much to the welfare of the Institute.

Our friend Professor Walter P. Copp, who died last January, joined the Institute in 1921 and was Treasurer from 1940-45 when, on retirement because of ill health, he was made an honorary member. A man of sterling character and unfailing good humor, he was beloved by students and colleagues alike. We shall miss him.

In the period under review seven ordinary members, four associate members and eighteen student members have been elected to the Institute. The total membership now stands at 151.

In addition to the Annual Business Meeting there have been five Ordinary Meetings at which the average attendance was 32. At the March meeting there was a vigorous discussion on "The Proposed Provincial Organization for Research in Nova Scotia" led by Dr. A. E. Cameron. On May 1st a joint meeting was held with the Maritime Section of the Chemical Institute of Canada at which an address was given

by Dr. A. Stanley Cook on "The History and Manufacture of Antibiotics." The address, which was interesting and timely, was illustrated by a colour film. On April 15th the members of the Institute were invited by the Halifax Branch of the Engineering Institute of Canada to attend a lecture on "Atomic Energy" by Dr. George C. Laurence. Many interesting demonstrations served to illustrate various phases of the subject.

At the Ordinary Meetings there were twelve papers and two demonstrations, embodying work by 28 investigators. Of these four each were in physiology and fisheries biology, two each in chemistry and zoology, and one each in anatomy and biochemistry. Mathematics and physics were again unrepresented. The fact is that while their more essential colleagues were concerned with war, the biological group has kept the Institute going. It is to be hoped that the pre-war balance of presentations at meetings will be restored before long. Meanwhile the proponents of the science of life may, if they choose, comfort themselves in the knowledge that their special skills are the skills of peace.

A double number of the "proceedings" was sent out during the past summer and another number, made up largely of an account of the Flora of Nova Scotia, is in press. Publishing difficulties have continued and the Editor has been sorely tried.

The officers and Council have cooperated with characteristic fidelity to make the year's programme a success. No less than ten Council meetings were held during the past winter. Dr. H. B. Collier, who has served most efficiently as Recording Secretary for three years, resigned on leaving Halifax to accept a Chair in the University of Saskatchewan. It is a pleasure to place on record the Institute's thanks and best wishes to him.

The membership of the Institute and the attendance at meetings probably stood last year at the highest level in our history. We are also solvent. This is interesting in view of the complete absence of innovations designed to make the Institute into more of a social organization, or to dilute or popularize its scientific reports. Living as we do in the golden age of advertising, it is a matter of satisfaction to discover that an organization can flourish when it has nothing to offer except solid worth.

In concluding this report, and also my term of office, I wish to tell you how greatly I have appreciated the honour of presiding over the society.

PROCEEDINGS OF MEETINGS

Session of 1946-47

(All meetings were held in the Medical Sciences Building, Dalhousie University, Halifax)

85th Annual Business Meeting, October 21, 1946.

The President, Dr. F. R. Hayes, was in the chair. His annual address is printed in full in the proceedings. Reports of officers were presented and are summarized as follows:

Treasurer's Report:

Receipts	$ 877.11
Expenditures	1,110.57
Total assets, current account	645.88
Total assets, permanent fund	6,000.00

The Corresponding Secretary reported that 273 numbers of back files had been sent out, and three new exchanges had been set up.

The Editor reported that parts 1 and 2 of Volume XXI of the Proceedings were published in February, 1946, and that parts 3 and 4 were now in the press.

The Librarian reported that 1,083 publications had been received through the exchange list, and that 1,502 books and pamphlets had been borrowed from the library.

Officers elected for the year 1946-47 were:

President	Dr. C. C. Coffin
1st Vice-President	Dr. C. B. Weld
2nd Vice-President	Dr. A. E. Cameron
Treasurer	Mr. D. K. Crowdis
Corresponding Secretary	Dr. W. J. Chute
Recording Secretary	Dr. W. J. Dyer
Council	Dr. F. R. Hayes, Dr. W. J. Archibald, Mr. R. E. S. Homans, Dr. E. Hess, Dr. E. C. Black.

Editor ..... Dr. E. Hess
Librarian ..... D. K. Crowdis, Esq.
Auditors ..... Prof. R. J. Bean
and Dr. H. L. Bronson

Nominations to Provincial Science Library Commission: Dr. J. H. L. Johnstone and Dr. E. G. Young.

1*st Ordinary Meeting*, November 18, 1946.

Papers: "The Reaction of $\beta\beta$'dichlorodiethyl Sulfide with Proteins," by E. G. Young and Roberta Campbell; "A Method of Preparing and Concentrating Radioactive Phosphorus," by C. C. Coffin and B. L. Funt.

2*nd Ordinary Meeting*, December 9, 1946.

The following new members were announced (elected by Council, November 7): R. W. Begg, M.D., Lt. L. B. Sellick, Mrs. Mary Price, M.Sc., ordinary members; G. L. Handrigan, B.Sc., A. M. Fleming, J. J. Phinney, B.Sc., J. A. Schwartz, B.Sc., Miss Margaret McPherson, B.Sc., Hilliard Pivnick, B.S.A., George Anderson, B.S.A., O. A. Sandoz, B.Sc., C. J. Moen, B.Sc., D. H. Rogers, B.Sc., M. A. Kierstead, M.A., C. K. Hoyt, E. A. MacKenzie, B.Sc., W. A. MacCallum, B.E., A. E. Croft, B.Sc., student members; (elected by Council November 18); C. R. Ross, R. E. S. Homans, M.A., ordinary members; (elected by Council, December 9): D. C. Horne, B.Sc., and D. G. Stairs, B.Sc., student members.

Papers: "Bryophytes and Lichens in the Pastures of the Maritime Provinces," by Eville Gorham; "An Approximate Solution of the Differential Equation of the Ultracentrifuge," by W. J. Archibald.

3*rd Ordinary Meeting*, January 13, 1947.

The following new members were announced (elected by Council, December 9): Chester Stewart, M.D.,C.M. and Cyril Read, B.A.Sc., ordinary members; (elected by Council, January 13): G. N. Milford, B.Sc., student member.

Papers: "Modifications to a Recording Microphotometer," by H. J. McLellan and A. F. Dunn; "The Anaerobic Decomposition of Glycogen in Living Yeast Cells," by J. G. Aldous; "Spoilage of Freshly Cut Fillets," by W. J. Dyer and Frances E. Dyer.

4th Ordinary Meeting, February 10, 1947.

It was announced that Harold D. Smith, Ph.D., President of the Nova Scotia Research Foundation, was elected an ordinary member by Council on February 10.

Papers: "The Vegetation of Eight Nova Scotian Lakes," by E. Gorham; "The Penetration of Moisture into Maritime Masonry Structures," by M. R. Foran, V. E. Vaughan and Thora Reid.

Extraordinary Meeting, March 17, 1947.

Dr. D. J. McLeod, Officer-in-charge, Division of Botany and Plant Pathology of the Dominion Experimental Station Fredericton, presented a paper "Plant Viruses," illustrating his lecture with numerous slides including electron microphotographs. A lively discussion followed.

5th Ordinary Meeting, April 7, 1947.

It was announced that the following members had been elected Honorary Members of the Institute by Council, on February 10: Dr. L. C. Harlow, Dr. H. E. Bigelow, Dr. H. L. Bronson, Dr. John Cameron, Mr. P. R. Colpitt, Dr. A. G. Huntsman, Dr. S. G. Ritchie, and Dr. F. H. Sexton. Dr. Robert Howland was elected ordinary member by Council, on February 24.

Papers: "The Resistance of Tomato Relatives and Hybrids to Certain Mycological and Entomological Pests," by L. P. Chiasson; "Sea Water as a Supplement to Fresh Water Rations," by M. G. Whillans.

6*th Ordinary Meeting*, May 5, 1947.

Papers: "Some Effects of Temperature on the Development of the Salmon," by E. Gorham; "The Colorimetric Estimation of Fish Muscle Protein," by J. M. Snow; "The Voltage Sensitivity of Two Galvanometers in Series," by H. J. MacLellan; "Propagation of Electromagnetic Waves in a Conducting Medium," by A. F. Dunn.

Demonstration: "A Stroboscopic Light Source," by R. M. LeLacheur.

ABSTRACTS

(Papers read before the Institute but not published in the Proceedings)

The Reaction of $\beta\beta'$dichlorodiethyl Sulfide With Proteins. E. Gordon Young and Roberta B. Campbell, Dept. of Biochemistry, Dalhousie University, Halifax, N. S. (Read November 18, 1946). The reaction of $\beta\beta'$dichlorodiethyl sulfide with various proteins and their constituents has been tested under relatively mild conditions of concentrations and of temperature. Most reactions have been carried out in aqueous media at 25° C., usually in the presence of sodium chloride. The rate of disappearance of mustard has been followed iodometrically as an index of the reaction. No reaction could be demonstrated with prolamins, zein and gliadin, in ethanolic solution. There was a definite reaction demonstrable with the keratin of human skin in which a 24% increment in total sulfur occurred and a more doubtful one with keratin from human hair. The most notable reaction took place with yeast and thymus nucleoproteins in which 250 per cent and 156 per cent increases of sulfur occurred respectively. Combination of mustard with both the protein and nucleic acid portions was demonstrated. The purines, adenine and guanine, were found to combine readily with mustard at 25° C. These experiments have led us to the conclusion that one of the major effects of mustard in its physiological action is the combination and precipitation of the nucleoproteins of the cell thus inhibiting natural processes of cellular regeneration.

A Method of Preparing and Concentrating Radioactive Phosphorus. C. C. Coffin and B. L. Funt, Chemistry Dept., Dalhousie University, Halifax, N. S. (Read November 18, 1946). The phosphorus atom (P31) in triphenylphosphate captures a slow neutron to form radioactive P32 which is kicked out of the molecule by X-ray recoil. By using an electric field of the order of 1000 volts per cm. it has been found possible to obtain virtually complete separation of the P32 from the stable isotope. Since no carrier is used high specific activities may be obtained. Samples having activities of the order of a million counts per gm. per minute have been prepared. The application of the method to other cases is being investigated.

An Approximate Solution of the Differential Equation of the Ultracentrifuge. W. J. Archibald, Physics Dept., Dalhousie University, Halifax, N. S. (Read December 9, 1946). One method of determining molecular weights is to allow a dilute solution of the substance to be studied to remain in a gravitational or centrifugal field of force until the equilibrium state has been reached. In this final state the concentration is a simple function of position. From the ratio of the concentrations at two points in the solution, at equilibrium, it is possible to compute the molecular weight of the dissolved substance. In the gravitational field of the earth the time to reach equilibrium may be very long; the time is much shorter if the strong fields available with the ultracentrifuge are employed. The concentration of a solution in a cell, placed in a centrifuge, at any point and at any time can be found by solving a certain differential equation. This differential equation has been solved exactly, but the mathematical functions which appear are unfamiliar and computations are difficult to perform. An

approximate solution has been obtained which gives reliable results for a relatively small expenditure of time. This approximate solution is described in the paper. This mathematical work is of importance to the experimenter using the ultracentrifuge for molecular weight determinations because it enables him to estimate how long he must wait for the equilibrium state to be reached. Furthermore, if the mathematics can be put in a usable form, it might be possible to measure molecular weights without waiting for equilibrium.

Modifications to a Recording Microphotometer. H. J. McLellan and A. F. Dunn, Physics Dept., Dalhousie University, Halifax, N. S. (Read January 13, 1947). A simple recording micro-photometer, similar to that described by Kulenkamph in Zeitschrift fur Physik, *36*, 56, (1935) was built with certain modifications and found to work satisfactorily. A vacuum tube, voltage regulated power supply was used for the photoelectric cell circuit; the optical system was improved; and a modification was introduced to enable the instrument to be used in analyzing the absorption spectra obtained with the Hilger quartz spectrometer.

The Anaerobic Decomposition of Glycogen in Living Yeast Cells. J. G. Aldous, Dept. of Pharmacology, Dalhousie University, Halifax, N. S. (Read January 13, 1947). An examination of the endogenous respiratory metabolism in resting cells of *Saccharomyces cerevisiae* shows that the cells are unable to ferment their carbohydrate-stores (glycogen). Evidence from the literature supporting the conclusion that glycogen may undergo some anaerobic decomposition has been shown to be erroneous.

Particular attention was directed toward respiratory quotient measurements of the respiration which ensued when the gaseous environment was changed from nitrogen to air. Of the two discrete metabolic phases shown to be present, both of which previously had been thought to concern glycogen decomposition, only the secondary phase is the result of glycogen oxidation. The primary phase is most likely to be due to substances carried over in the cell from the growth medium. Since glucose, but not glycogen is fermented, it follows that in the intact yeast cell the routes of decomposition of these metabolites must be different.

Spoilage of Freshly Cut Fillets. W. J. Dyer and Frances E. Dyer, Atlantic Fisheries Experimental Station, Halifax, N. S. (Read January 13, 1947). The interior flesh of a gutted fish stored in crushed ice remains sterile until an advanced stage of spoilage, only the skin surface and the visceral cavity being infected with bacteria. In consequence the surface of a freshly cut fillet will have only the bacterial load picked up during the filleting operation, and therefore the rate of spoilage depends only on this bacterial load and not on the age or condition of the fish before filleting. Results are shown for fillets cut from gutted cod stored from 1 to 13 days in ice bearing out this conclusion.

The Vegetation of Eight Nova Scotian Lakes. E. Gorham, Biology Dept., Dalhousie University, Halifax, N. S. (Read February 10, 1947). A list is given of 133 forms of plants found in eight No a

Scotian lakes. The dominant species of the submerged, emerged and horeline vegetation and the factors governing their abundance are discussed for each of the lakes studied.

The Penetration of Moisture into Maritime Masonry Structures. M. R. Foran, V. E. Vaughan and Thora Reid, Chemistry Dept., Dalhousie University, Halifax, N. S. (Read February 10, 1947). A survey made for the Department of Reconstruction and Supply showed that a considerable portion of the masonry structures suffered in varying degree from this effect. Although a change in the quality of workmanship in various periods has been a contributing factor, fundamental physical and chemical factors have been involved. A climate which provides 81 cycles of freezing and thawing, 37 gales, 71 inches of rain, and 167 foggy and rainy days per year has been an accelerating factor. Local sand appeared to produce mortars of greater porosity than standard sand and the relative porosites of Maritime mortars and building units have been tabulated. The volume changes, strengths, porosities and durabilities of cement-lime mixtures made with local sand have been described. Suggestions for further investigation of this problem in regard to the reaction between Portland cement and local aggregates, accelerated testing procedures, new materials and methods of assembly have been made.

The Resistance of Tomato Relatives and Hybrids to Certain Mycological and Entomological Pests. Leo P. Chaisson, Biology Dept., St. Francis Xavier University, Antigonish, N. S. (Read April 7, 1947). During the last decade a number of interspecific crosses have been made among members of the tomato genus *Lycopersicon*. The resistance of various wild species of *Lycopersicon* and of some interspecific hybrids to a strain of tomato leaf mold, *Cladosporium fulvum*, and to tomato leaf spot, *Septoria lycopersici* was demonstrated by plants set out in the field, and by those planted in the greenhouse. This resistance was also confirmed through controlled tests performed in the greenhouse by means of artificial inoculations. The species *L. hirsutum* is also resistant to parasitization by red spider. An appropriate backcross population, involving an interspecific hybrid of *L. hirsutum* and a domestic tomato variety, segregated for such resistance.

Sea Water as a Supplement to Fresh Water Rations. M. G. Whillans, Dept. of Pharmacology, Dalhousie University, Halifax, N. S. (Read April 7, 1947). Under controlled environmental conditions, R.C.A.F. volunteer subjects consumed regular issue emergency rations of food and fresh water (450 cc. daily) for seven days. Half of these subjects drank 300 cc. of sea water daily additional to the fresh water ration. Blood and urine chemical studies showed no storage of chloride, and no significant effects attributable to the sea water. The subjects who drank the sea water lost approximately 25% less weight than the controls.

Some Effects of Temperature on the Development of the Salmon. Eville Gorham, Dept. of Biology, Dalhousie University, Halifax, N. S. (Read May 5, 1947). The effect of temperature has been followed on processes of differentiation in the salmon embryo (*Salmo salar*). It has been found that these processes may be affected in different degree under different developmental temperatures within the

limits for survival, and a change in the order of appearance of certain structures obtained. This phenomenon may be of fundamental importance in explaining the thermal limits of developing embryos and perhaps those of adults. As a result of this dislocation it appears that stages of development drawn up for one temperature will not necessarily apply under another.

The effect of temperature on differentiation seems to follow most closely the rule of thermal summation, the rate (reciprocal of time for morphological feature to appear) varying directly as the temperature. The rates for the various processes are somewhat differently affected. The Q10 declines from the warm to the cool end, being largely between 2 and 5.

Some evidence indicates that the lethal limits vary from stage to stage, being relatively narrower during cleavage and at hatching. In the production of abnormalities there appears to be a relation within limits between temperature and stage, a higher temperature being required to induce the same degree of bending in the embryo when applied at a later stage. An acclimation to high temperature is indicated in the case of fat production in the mesentary supporting the gut.

The Colorimetric Estimation of Fish Muscle Protein. J. M. Snow, Atlantic Fisheries Experimental Station, Halifax, N. S. (Read May 5, 1947). A procedure for the colorimetric determination of protein has been developed. This is a simplified modification of the biuret test, having a sensitivity of 0.8 to 8.0 mg. protein in a 5 ml. sample, and an accuracy of less than two per cent. The method is extremely rapid and has been used successfully for several hundred estimations in fish muscle protein, having been applied to various studies in frozen fish denaturation.

The Voltage Sensitivity of Two Galvanometers in Series. H. J. McLellan, Dept. of Physics, Dalhousie University, Halifax, N. S. (Read May 5, 1947). The treatment of galvanometer behavior in terms of an equivalent circuit (originally due to Butterworth) is extended to cover the behavior of two galvanometers in series. The implications are studied and an experimental check is made on the theory.

Propagation of Electromagnetic Waves in a Conducting Medium. A. F. Dunn, Dept. of Physics, Dalhousie University, Halifax, N. S. (Read May 5, 1947). The propagation of electromagnetic waves in a large body of sea water has been investigated through the use of a laboratory size scale model, with corresponding changes in frequency and conductivity, utilizing mercury as the medium. The experimental results are in reasonable agreement with theory for the case of sinusoidal waves. The experimental results for a square wave agree fairly well with the theory for a square wave made up by superimposing sinusoidal waves in a Fourier series of harmonics.

A Stroboscopic Light Source. R. M. LeLacheur, Physics Dept., Dalhousie University, Halifax, N. S. (Read May 5, 1947). A stroboscopic light source is described using the "Strobotron" as developed by Germeshausen and Edgerton. Provision is made for calibrating the flash frequency either against the power main frequency or against an external standard. An external triggering circuit is also installed.

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[Halifax]

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CONTENTS

Fresh-Water Algae of the Maritime Provinces. Elwyn O. Hughes.. 1

Tetrastichus Minutus (Howard) (Hymenoptera: Eulophidae) Reared from the Lady-Beetle, *Adalia Bipunctata* L. W. W. Judd..... 64

Presidential Address. C. C. Coffin..... 68

Proceedings of Meetings. Session 1947-48..... 70

Abstracts. (Papers read before the Institute but not published in the Proceedings)..... 74

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HARVARD UNIVERSITY

FRESH-WATER ALGAE OF THE MARITIME PROVINCES*

Elwyn O. Hughes

Department of Plant Sciences

The University of Oklahoma

(Received for Publication: July 19, 1948)

Abstract

A catalogue is given of 537 species and varieties of fresh-water algae (excluding diatoms) from the Maritime Provinces of Canada The list includes all forms reported by previous workers and 339 species collected by the author. The introduction includes a summary of previous investigations of the fresh-water algae in the Maritime Provinces and a brief discussion of factors affecting the distribution of these plants, New varieties of the following species are described: *Oedogonium zehneri* Tiffany, *Closterium angustatum* Kuetz., *Closterium acerosum* (Schrank) Ehrenb., *Cosmarium eloisianum* Wolle, *Cosmarium panamense* Prescott, *Cosmarium quinarium* Lund.

INTRODUCTION

The Maritime Provinces of Canada, including New Brunswick, Nova Scotia and Prince Edward Island, cover an area of more than 51,000 square miles and are practically unexplored territory so far as investigation of the fresh-

*The greater part of this paper was presented in 1942 as a dissertation in partial fulfillment of the requirements for the degree of Doctor of Philosophy at the Ohio State University. Publication was not attempted at that time because of the author's transfer to non-botanical activities. During the past two years, numerous species and county records have been added to the algal flora by further examination of the author's collections. The latter part of the investigation has been carried out at the University of Oklahoma.

water algae is concerned. The algae of the New England States have been investigated since the middle of the nineteenth century by a large number of competent workers. In recent years W. R. Taylor (1934, 1935) and Irénée-Marie (1939) have made extensive contributions to our knowledge of the algal flora of Newfoundland and Quebec. Previous workers have reported 286 species and varieties of fresh-water algae from the Maritime Provinces. The present paper increases the known total to 537 species and varieties, 339 of which are in the writer's collections, and 251 of which are new records for the region.

Earliest reports of fresh-water algae from Nova Scotia are those of the British phycologists, Joshua (1885) and Turner (1885). Since the collections came from Pictou County, it is probable that the collector in each case was A. H. Mackay to whom credit is given by Joshua. A dozen species from Halifax County were added to the Nova Scotian flora by Borge (1909). Roscoe (1931) included two species of *Batrachospermum* in a paper primarily concerned with marine algae of St. Paul's Island, Victoria County. More recently, M. W. Smith (1938) listed seventy-two species and varieties of plankton algae (excluding diatoms) from Lake Jesse in Yarmouth County. Six new species of filamentous green algae from Queens County, N. S., have been described by the present author (Hughes, 1948).

The first person to exhibit an extended interest in the micro-flora of the Maritimes was J. M. Baxter, a physician at Chatham, N. B. This investigator, using Wolle's manuals as a means of identification, reported nearly a hundred species of desmids from Northumberland County in the years 1903, 1905, and 1907. In 1921, A. B. Klugh described a new genus and three new species of blue-green algae from the Miramichi River, N. B. Later, in connection with an ecological study of the fresh-water Entomostraca, Klugh (1927) reported forty-nine species, principally Myxophyceae and Chlorococcales, from the neighborhood of the Atlantic Biological Station

at St. Andrews, Charlotte County, N. B. The latest contribution to the algal flora of New Brunswick was made by Habeeb and Drouet (1948) who list seventy-seven species, principally Myxophyceae, from the neighborhood of Grand Falls, Victoria County.

PHYSIOGRAPHY

Nova Scotia and Prince Edward Island may be divided into two physiographic regions (Map I). The *Upland Region* includes all of the Atlantic coastal area (Southern Upland) as far inland as the Annapolis Valley and with an irregular boundary from Windsor to Chedabucto Bay. Outliers of this Southern Upland are the Cobequid Mountains, the Pictou-Antigonish Highland, and the Cape Breton Highlands. The principal underlying rocks of these areas are Precambrian granites, and Cambrian quartzites and slates. The Upland Region corresponds to the base level of the Atlantic peneplain of Cretaceous time. Altitude increases from sea-level westward to over 1000 feet in the Cobequid Mountains, and northward to nearly 1400 feet in the Cape Breton Highlands. This northwestward increase in altitude is a result of tilting of the Atlantic peneplain towards the end of the late Cretaceous period.

The *Lowland Region* consists of Prince Edward Island and most of the Isthmus of Chignecto as far south and east as the Southern Upland. The substrate of the lowland consists principally of Devonian, Carboniferous, and Triassic sandstones, shales, limestone, and gypsum beds. The Lowland Region has been developed since the tilting of the Atlantic peneplain by the more rapid erosion of less resistant rocks. Prince Edward Island is the remnant of a water-shed on the now submerged Acadian Plain. The average altitude of the lowland is approximately 200 feet above sea level, but a few isolated points reach a height of 400 to 600 feet.

Both the upland and the lowland regions of the Maritimes show plentiful evidence of Pleistocene glaciation. Deposition

of debris by the retreating ice resulted in marked disarrangement of the pre-glacial drainage pattern. Hundreds of lakes and bogs are now found in the ancient river valleys of the southern upland. Except for the presence of some foreign boulders at the west end, the record of glaciation on Prince Edward Island is obscure. The thin mantle of red drift is apparently derived from the same type of sandstone and shale that form the bed-rock, indicating that the ice must have advanced from the north.

Basing his conclusions on interpretations of glacial striae and analyses of drift, Goldthwait (1924) concluded that Nova Scotia had been glaciated by a southeastward-moving lobe of ice advancing from New Brunswick and later by a southward movement of ice which crossed Prince Edward Island from the direction of Labrador. Later workers are of the opinion that a powerful, early glaciation from Labrador covered all of the provinces. This advance was followed by a long interglacial period and a relatively weak Wisconsin glaciation. The presence of relict plants on the islands of Prince Edward, Cape Breton, and the Magdalen group is accepted by the latter school as evidence of incomplete glaciation in Wisconsin time. (Coleman, 1941; Marie-Victorin, 1938).

CLIMATE

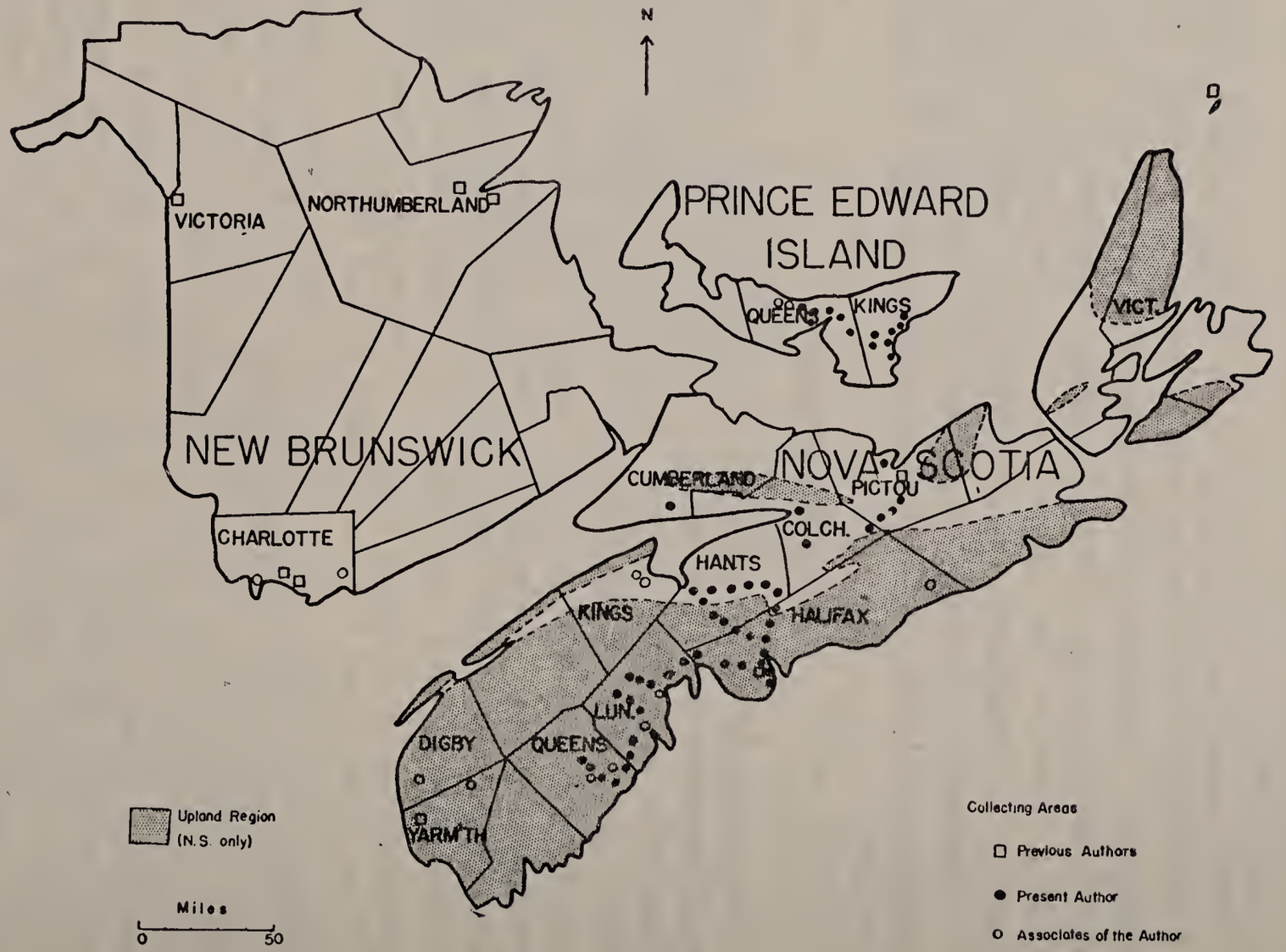
Different parts of the Maritime Provinces have marked differences in climate. Middleton (1935) has referred to the "climates of eastern Canada" whereas Putnam (1940), more conservatively, has divided the climate into several distinct regions. In general, the prevailing eastward movement of the air masses results in a change from a continental climate in northern New Brunswick to one under a major marine influence in Prince Edward Island and Nova Scotia. The oceanic effect is well illustrated by the reduction of the extreme annual temperature range from 150°F. in northern New Brunswick to 131°F. in south-eastern Nova Scotia, accompanied by a

lengthening of the frost-free period from 91 to 143 days. The maximum recorded temperatures for Prince Edward Island and southern Nova Scotia are 92° and 99°, the minima being -27° and -32° respectively.

The average annual precipitation is high in both Upland and Lowland regions, being approximately 51 and 40 inches respectively. Included in these figures are six to seven feet of snow, which falls from November to April inclusively. Steady drizzling rains are far more common than heavy showers. Fogs are frequent along the Atlantic Coast especially during the summer. Precipitation is rather equally distributed throughout the year with a slight increase in the six months of winter.

VEGETATION

As might be expected from the climatic data, the Maritime Provinces come well within the limits of the Hemlock-White Pine Hardwood region, described by Nichols (1918, 1935). A forest classification set up by Halliday (1937) gives a brief description of the forest types present in the Maritimes to-day. Halliday's forest sections correspond rather closely to Goldthwait's physiographic divisions of the provinces (1924) and (somewhat less closely) to the climatic regions set up by Putnam (1940). The original climax forest of Nova Scotia and Prince Edward Island consists of sugar maple, yellow birch, beech, white pine, hemlock, and balsam fir. This association was particularly well developed in the lowland areas but, in the original condition, is now rather rare, particularly on Prince Edward Island. The forest association most prevalent on the Upland Region of Nova Scotia consists of balsam fir, black, red, and hybrid spruce. This type of forest is especially wide-spread at higher altitudes in the highland regions of Cape Breton, in the more exposed eastern coastal areas, and in the more elevated parts of the southern upland. In the southern counties, however, the climax association is frequent on physiographically favorable sites.


N
VICTORIA
NORTHUMBERLAND
PRINCE EDWARD ISLAND
QUEENS
KINGS
VICT.
NEW BRUNSWICK
CUMBERLAND
NOVA SCOTIA
PICTOU
COLCH.
CHARLOTTE
HANTS
KINGS
HALIFAX
LUN.
DIGBY
QUEENS
YARM'TH
Upland Region (N.S. only)
Miles
0
50
Collecting Areas
Previous Authors
Present Author
Associates of the Author

MAP 1

DISCUSSION OF THE ALGAL FLORA

Collections. The great majority of the collections on which this paper is based, were made by the writer in the months of June, July and August, 1939 and 1941. Twenty-five samples of plankton, collected in the summers of 1936, 1938, 1939, and 1948, were contributed by M. W. Smith of the Atlantic Biological Station. Dr. Smith's collections were made in small lakes and ponds in Charlotte County, New Brunswick, Digby and Yarmouth Counties, Nova Scotia, and Queens County, Prince Edward Island. Six collections from Goldmine Brook, Moser's River, Halifax County, N. S., were sent in by J. A. C. Nicol, then connected with the Fisheries Research Board. In 1942, twenty collections from Kings, Queens, and Lunenburg Counties, N. S., were contributed by W. G. Dore and A. E. Roland.

In making his collections, the writer travelled by automobile along the highways and side-roads of the eastern counties of Prince Edward Island, and the central counties of Nova Scotia. Points at which collections were made are indicated on the accompanying map (Map I). All collections were preserved in Transeau's solution (6 parts water, 3 parts 95% ethyl alcohol, 1 part formalin).

Habitat Relationships. The habitats from which algae were collected, fall into the following categories in order of frequency: streams, lakes, ponds, artificial ponds (dammed streams), bogs and springs. A distinct difference between the frequency of the various types of habitat in the Upland and Lowland Areas is shown by the following data.

Collections classified as to habitat:

	Upland	Lowland
Streams	31%	31%
Lakes	35%	6%
Ponds	10%	27%
Artificial Ponds (dammed streams)	4%	21%
Bogs	13%	0%
Springs	0%	9%
Miscellaneous (Wet mud, roadside ditches, etc.)	7%	6%

The large percentage of lake and bog collections in the upland area is accounted for by the poor drainage characteristic of the region. Nearly all of the lakes are glacial in origin, occurring in undrained depressions or in pre-glacial channels now blocked by glacial debris. The pond habitats are more temporary in nature, e.g. water accumulated in gravel pits and depressions in pasture fields. The ponds in Prince Edward Island National Park are formed at the mouths of small streams by barriers built up above the high tide level. The "rivers," appearing on maps of Prince Edward Island are largely tidal estuaries, hence fresh-water algae occur only in the upper reaches where the streams may be little more than brooks. Many of these streams have been dammed to provide water-power for saw-mills or electric power plants. This accounts for the predominance of "artificial pond" collections in the lowland area. Because of excellent drainage in the sandstone areas, there are relatively few lakes and these, for the most part, are fed by underground strams. Most of the streams and tributary brooklets of Prince Edward Island are spring-fed.

Earlier algologists were impressed with the richness of the desmid flora in geologic regions older than the carboniferous and, at first, this peculiarity of distribution was attributed to the antiquity of the rocks. In later years, the phenomenon has been related to the acid nature of the waters and more recently to the higher concentration of K-Na ions in relation to Ca-Mg ions (Nichols and Ackley, 1932), (Prescott and Scott, 1943). Unfortunately, the author has no data on the pH or chemical constituents of the waters in which his collections were made. He knows, however, that desmids were far more abundant in numbers and in richness of species in his collections from the Upland Region than they were from the Lowlands of Prince Edward Island and northwestern Nova Scotia.

The plankton of the Upland lakes is of the characteristic Caledonian type in waters low in pH and poor in calcium.

A survey of such a lake has been published by M. W. Smith (1938) including the relevant physical and chemical data. The Upland lakes contain great numbers of desmid species, *Xanthidium*, *Arthrodesmus*, and the long armed species of *Staurastrum* being especially common. Species of *Closterium* and *Cosmarium* are also important constituents of the phytoplankton. The colonial blue-greens, *Chroococcus*, *Coelosphaerium*, and *Microcystis* occur quite generally. Colonies of *Dinobryon* were present in nearly all the upland lake collections. In Boar's Back Lake (pH 4.3-4.6) a great quantity of *Peridinium limbatum* was present.

The plankton algae of the ponds of Prince Edward Island National Park are of the Baltic type with a predominance of colonial and filamentous blue-greens, while the greens are represented by colonial genera of the Chlorococcales. One of these ponds contained *Chaetoceros* sp., a marine diatom, the presence of which probably indicates contamination by sea-water at high tide. The mill-ponds of the Island contain great quantities of *Oedogonium* in floating mats. *Spirogyra* is usually present, but less abundant.

Most of the algae occurring in the Prince Edward Island collections are characteristic of alkaline waters. Except for the genera *Closterium*, *Cosmarium*, and *Staurastrum*, desmids are rather rare. Correspondence (M. W. Smith, 1942; Hurst, 1942) and conversation with fisheries and agricultural investigators confirm the conclusion, indicated by the algal flora, that the fresh waters of Prince Edward Island are generally alkaline in reaction. Soils of the Island are typically podsolic in profile, and acid in reaction. Agricultural soils give a reaction from pH 4.8 to pH 7.4, the higher pH readings indicating soils that have been heavily limed. The alkalinity of the waters may therefore be due to the presence of some unknown underlying strata of limestone or to the cementing material of the red surface sandstones.

The only lowland habitats supporting an appreciable variety of desmids are the semi-permanent ponds. The

general aspect of such ponds is marshy, with marginal sedges and cat-tails. Decaying vegetation and drainage from the surrounding acid soils results in a lowering of the pH in these poorly drained depressions.

Most of the rapidly flowing rocky brooks and streams of the Maritime Provinces are sterile except for occasional red algae. The sandy or gravelly streams (usually slower-running) contain *Tetraspora*, *Ulothrix*, *Draparnaldia*, *Mougeotia* and *Bulbochaete*. Epiphytic and plentiful on *Tetraspora* and *Draparnaldia* at three such habitats was *Chaetonema ornatum* Transeau hitherto unknown except from Alabama. A brook at Vernon River, Prince Edward Island, yielded the only collection of *Schizomeris*. In the quiet pools at stream and river margins, one frequently finds the common desmids, *Closterium*, *Cosmarium*, and *Staurastrum*, intermingled with *Oedogonium* and *Spirogyra*. *Vaucheria* is particularly common in the brooks of the lowland region.

Distributional Relationships. The fresh-water algae are an extremely cosmopolitan group, most of the genera and many of the species being found on all of the continents. No one has succeeded in demonstrating that the distribution of fresh-water algal associations follows the same pattern as that of the higher vegetation. The nature of the latter is largely determined by precipitation and other atmospheric factors. Water is however a constant factor in permanent rivers, streams, lakes and ponds. The nature of the algae present in an aquatic habitat is therefore dependent upon the availability of light, temperature and the physical and chemical nature of the water. Attempts have been made to correlate rich desmid floras with glaciated regions or areas of igneous rock. Increased knowledge of the algae of the unglaciated southeastern United States and the algae of bogs and lakes not underlain by igneous rock has however demonstrated that this correlation was more apparent than real, (Prescott and Scott, 1943). Our extremely limited knowledge of the actual micro-environment in which a given

species may occur makes it impossible to explain many peculiarities of distribution of the algae. Northeastern America contains thousands of unexplored lakes, ponds and pools. Fernald's remarks (1918) on the vascular plants of this area are even more applicable to the fresh-water algae. "The number of remarkable species discovered in a given area seems limited only by the number of pools visited.—Until we know the species and varieties that constitute the flora, it is premature to enter into generalizations which depend for their accuracy on unquestionable premises."

Taylor and Fogg (1927) and Taylor (1934) have indicated their belief that the distributional relationships of the vascular flora of Newfoundland might be paralleled by that of the fresh-water algae. The former paper refers particularly to *Micrasterias arcuata* Bailey and the variety *expansa* (Bail.) Nordst. which range south along the Atlantic coast and appear in Newfoundland far to the north of their previous northernmost record in Massachusetts. In the latter paper, Taylor states that "some idea of a coastal plain, or at least of a southern element, was possible." Eight species of desmids are recorded which might possibly be significant. Four of these species are now reported from Quebec, including three also found in Michigan (Irénée-Marie, 1939; Taft, 1939; Nichols and Ackley, 1932). Of these species, four, *Docidium undulatum*, *Micrasterias arcuata* var. *expansa*, *Pleurotaenium rectum*, and *Staurastrum brachiatum* are present in the MaritimeProvinces, indicating an east-west range as well as a north-south distribution. Nearly every new algal list published causes a similar revision of our previously held ideas on the range of this or that species. Of the desmids present in the Maritime Provinces, over eighty species occur on the southern coastal plain (Brown, 1930). Since all but one of these plants are present also in the floras of Michigan and Quebec, we can hardly consider them as part of a distinct coastal plain element.

The coastal plain relict theory is of great value in explain-

ing the distribution of vascular plants whose peculiar range cannot be cleared up on the basis of migration under present-day conditions. Ornithologists have never found migrating birds carrying viable vascular plant debris, either internally or externally, over long distances. It has therefore been assumed that such propagules are not carried from the south-eastern Atlantic coast to Acadia. It is, however, reasonably certain from the investigations of Irênée-Marie (1939) that waterfowl play an important part in the dispersion of the fresh-water algae. The legs of a blue heron brought down between two bogs near Montréal, when washed in filtered water, yielded 12 cells of 15 species belonging to eight desmid genera. The plumage of a duck, similarly examined, was found to be carrying at least 517 specimens of 31 desmid species. Many of the cells were green and carried on division after three days in culture. An important point in this connection is the fact that thousands of desmid cells could be carried in a very small drop of water.

The Maritime Provinces are located on the important Atlantic fly-way used by migrating birds in the spring and autumn. Lincoln (1939) points out that "it appears that migration in general is performed in a leisurely manner, that, after a flight of a few hours along the accepted route, birds stop to feed and rest" . . . "the Canada goose affords a typical example of regular but unhurried migration." The latter bird takes about one to two months to complete its migration from the Carolinas to the Gulf of St. Lawrence region. It is well within the limits of probability that such waterfowl have brought about a great deal of the dispersion of desmids along the Atlantic Coast.

Another active agent in the dispersion of the fresh-water algae is the wind. Irênée-Marie (1939) refers to the western dust-storms which, in recent years, have caused precipitation of dust over immense areas as far east as Virginia and the Gulf of St. Lawrence. His examination of dust, collected over a two month period, disclosed the presence

of several diatom frustules and a number of specimens of *Closterium lunula* and *Cosmarium pyramidatum*. Obviously, these dried out skeletons would play no part in the propagation of the species, but the inference is easily drawn that thick-walled aplanospores, zygospores, etc., from dried-out habitats may be carried in this manner.

Smith (1933) has indicated his belief that, even in the vegetative condition, many algae are carried over long distances by birds and wind. If this be true, it is certainly unnecessary to explain the distribution of the fresh-water algae on the basis of the migration routes available to vascular plants. Even if great numbers of coastal plain algae are also reported from Nova Scotia and Newfoundland, it is quite possible that their distribution can be explained on the basis of present day factors.

Systematic Treatment. In the following catalogue, the classification, with minor deviations, is that used by G. M. Smith (1933,1938). In the first five phyla, genera and species are listed alphabetically. Members of the Chlorophyta are classified as to order and family, with the genera and species arranged alphabetically under the family heading.

The number of Maritime species of *Bulbochaete*, *Oedogonium*, *Mougeotia*, *Spirogyra*, *Zygnema*, and *Vaucheria* is without doubt much greater than appears from this list. Unfortunately the sexual stages necessary for specific identification of these genera were not present in a majority of the collections. Other genera present in the collections, but unidentifiable because of poor preservation or lack of reproductive stages are *Adouinella*, *Batrachospermum*, *Euglena*, *Phacus*, *Volvox*, *Tetraspora*, and *Pleurodiscus*.

The catalogue of species includes all forms (exclusive of diatoms) reported by previous workers. Where possible, the synonymy of earlier records is given. *Species occurring in the author's collections are indicated by an asterisk.* Distributional data are given by county for all species, and habitat records are given for the author's identifications. After each

species and variety identified by the author, a reference is given given to an adequately illustrated description of the plant in question. When the species listed varies in some respect (e.g. size, shape, or ornamentation) from the cited description, the differences are recorded. When the variation cannot be adequately described in words, an illustration has been prepared (Plates I-IV). In the course of identifying the species, the author has kept camera lucida drawings of all the rare forms and many of the common forms encountered. In view of the many fine published figures of these species, it would seem to be a needless duplication of effort to append over five hundred drawings to this catalogue. In the long run, the validity of taxonomic lists, as of all other scientific papers, depends upon the integrity of the author.

CATALOGUE

(Figures in brackets refer to the Literature cited pp. 53-56;

Species occurring in the author's collections are indicated by an asterisk (*).

CYANOPHYTA

Myxophyceae

Anacystis rupestris (Lyngb.) Drouet & Daily	N. B. Victoria (20)
Anabaena circinalis (Kuetz.) Rabenh..	N. S. Yarmouth, lake (51)
**A. circinalis* Rabenh. var. *macrospora* (Wittr.) Forti (16)	N. S. Cumberland, ditch
A. inaequalis B. & F.	N. B. Victoria (20)
Amphithrix janthina B. & F.	N. B. Victoria (20)
**Aphanocapsa delicatissima* W. & G. S. West	N. S. Yarmouth, lakes (51)
Aphanothece pallida (Kuetz.) Rabenh..	N. B. Charlotte (?) (28)
A. saxicola Naeg.	N. B. Charlotte (28)
**A. stagnina* (Spreng.) A. Braun (16)	N. B. Charlotte (28) N. S. Halifax, lake
Calothrix braunii B. & F.	N. B. Charlotte (28)
C. juliana B. & F.	N. B. Victoria (20)
C. parietina B. & F.	N. B. Victoria (20)
Chamesiphon polonicus (Rostaf.) Hansg.	N. B. Victoria (20)
**Chroococcus dispersus* (von Keissler) Lemm. (60)	P. E. I. Queens, pond
**Ch. limneticus* Lemm. (60)	N. S. Yarmouth (51) N. S. Halifax, lake
Ch. turgidus (Kuetz.) Naeg.	N. B. Charlotte (28) N. S. Yarmouth, lake (51)
Coelosphaerium kuetzingianum Naeg.	N. S. Yarmouth, lake (51)
**C. naegelianum* Unger (60)	N. B. Charlotte, lakes N. S. Yarmouth, lake
Cylindrospermum licheniforme B. & F.	N. B. Victoria (20)
C. majus B. & F.	N. B. Victoria (20)
C. muscicola B. & F.	N. B. Victoria (20)
**Dactylococcopsis raphidioides* Hansgirg (47)	N. S. Queens, Bog pool
Dichothrix baueriana B. & F.	N. B. Victoria (20)
D. gypsophila B. & F.	N. B. Victoria (20)
Fischerella ambigua (B. & F.) Gom.	N. B. Victoria (20)
Gloeocapsa alpicola (Lyngb). Born.	N. B. Victoria (20)

G. membranina (Menegh.) Drouet & W. A. Daily	N. B. Victoria (20)
G. turgida (Kuetz.) Hollerb.	N. B. Victoria (20)
Gloeothece membranacea (Rabenh.) Bornet	N. B. Charlotte (28)
Gomphosphaeria naegeliana (Ung.) Lemm.	N. S. Halifax (5)
Hydrocoleum homoeotrichum Gom.	N. B. Victoria (20)
Lyngbya ochracea Gom.	N. B. Victoria (20)
**Merismopedia punctata* Meyen (47)	N. S. Halifax, lake
**M. glauca* (Ehrenb.) Naeg. (47)	N. B. Charlotte (28)
	N. S. Yarmouth, lake (51)
	N. S. Halifax, lake
**M. tenuissima* Lemm. (60)	P. E. I. Queens, pond
Microcoleus acutissimus Gardn.	N. B. Victoria (20)
M. paludosus Gom.	N. B. Victoria (20)
M. vaginatus Gom.	N. B. Victoria (20)
**Microcystis aeruginosa* Kuetz. (11)	N. B. Charlotte (28)
M. flos-aquae is listed by Klugh but should be included in *M. aeruginosa* according to Drouet and Daily.	N. S. Yarmouth, lake (51) P. E. I. Queens, pond
M. marginata Kuetz. (11) This species has been referred to the genus *Aphanothece*.	N. B. Charlotte (28)
M. amethystina (Filarsky) Forti This species is not mentioned in Drouet and Daily's review of the genus.	N. B. Charlotte (28)
Nostoc comminutum Kuetz.	N. B. Charlotte (28)
N. commune B. & F.	N. B. Victoria (20)
N. depressum Wood	N. B. Charlotte (28)
N. microscopicum B. & F.	N. B. Victoria (20)
N. muscorum B. & F. (?)	N. B. Victoria (20)
Oligoclonium inequale Klugh. Geitler (16) refers this species to the genus *Hydrocoleus*.	N. B. Northumberland (27)
Oscillatoria formosa Gom.	N. B. Victoria (20)
O. splendida Greville	N. B. Charlotte (28)
O. tenuis Gom.	N. B. Victoria (20)
	N. B. Charlotte (28)
O. tenuis var. *natans* Gom.	N. B. Victoria (20)
Phormidium autumnale Gom.	N. B. Victoria (20)

Ph. favosum Gom.	N. B. Victoria (20)
Ph. incrustatum Gom.	N. B. Victoria (20)
**Ph. mucicola* Naum & Huber (11) Drouet and Daily express doubt as to the algal nature of this organism which grows in the pectic sheath of *Microcystis aeruginosa.*	P. E. I. Queens, pond
Ph. papyraceum	N. B. Victoria (20)
Ph. retzii (Agardh) Gom.	N. B. Charlotte (28)
Ph. setchellianum Gom.	N. B. Victoria (20)
Ph. tenue Gom.	N. B. Victoria (20)
Ph. uncinatum Gom.	N. B. Victoria (20)
P. purpureum Gom.	N. B. Victoria (20)
Schizothrix friesii Gom.	N. B. Victoria (20)
S. heufleri Gom.	N. B. Victoria (20)
S. lacustris Gom.	N. B. Victoria (20)
S. stricklandii Dr.	N. B. Victoria (20)
Scytonema figuratum B. & F.	N. B. Victoria (20)
S. guyanense B. & F.	N. B. Victoria (20)
S. hoffmanii B. & F.	N. B. Victoria (20)
S. myochrous B. & F.	N. B. Victoria (20)
S. ocellatum B. & F.	N. B. Victoria (20)
**Spirulina major* Kuetz. (16)	P. E. I. Queens, pond
Stigonema subsalsa Klugh.	N. B. Northumberland (27)
Symploca muscorum Gom.	N. B. Victoria (20)
Tolypothrix brevicellularis Klugh	N. B. Northumberland (27)
T. tenuis Kuetz.	N. B. Charlotte (28)

PYRROPHYTA

Dinophyceae (13, 67)

**Ceratium cornutum* (Ehrenb.) Clap. & Lach.	N. S. Queens, artificial lake
**C. curvirostre* Huitfeld-Kaas	N. S. Queens, lake N. S. Yarmouth, lake
**C. hirundinella* Schrank	N. B. Charlotte, lakes P. E. I. Queens, pond
**Glenodinium aciculiferum* (Lemm.) Lindemann?	P. E. I. Queens, pond
Peridinium cinctum Ehrenb.	N. S. Yarmouth, lake (51)
**P. limbatum* (Stokes) Lemm. Plate III, Fig. 10 w. 61-67μ; l. 71-80μ In identifying this rarely reported	N. B. Charlotte, lake N. S. Digby, lake

species, Dr. Samuel Eddy (14) remarked that no complete description had ever been published.
P. limbatum also occurs in the lakes of Northern Minnesota.

**P. volzii* Lemm.	N. S. Queens, artificial lake
**P. wisconsinense* Eddy	N. S. Lunenburg, lake

RHODOPHYTA

Rhodophyceae

Batrachospermum vagum (Roth.) Ag.	N. S. Victoria (45)
B. moniliforme Roth.	N. B. Victoria (20)
	N. S. Victoria (45)

EUGLENOPHYTA

Euglenophyceae

**Trachelomonas hispida* (Perty) Stein (9)	N. S. Halifax, bog
**T. oblonga* Playfair var. *attenuata* Playfair (9)	N. S. Halifax, bog
**T. volvocina* Ehrenb. (9)	N. S. Hants, pool

CHRYSOPHYTA

Xanthophyceae

**Botryococcus braunii* Kuetz. (60)	N. B. Charlotte, lake
	N. S. Yarmouth (51)
	N. S. Queens, artificial lake
**Characiopsis cylindricum* (Lambert) Lemm.	N. S. Digby, lake
**Ch. longipes* (Rabenh.) Borzi (60)	N. S. Queens, artificial lake
Ophiocytium arbuscula (A. Braun) Rabenh.	N. B. Charlotte (28)
O. cochleare (Eichwald) A. Braun	N. B. Charlotte (28)
**O. majus* Naeg. (37)	N. B. Charlotte (28)
	N. S. Queens, lake
**O. parvulum* (Perty) A. Braun (60)	N. B. Charlotte (28)
	N. S. Hants, pool
**Stipitococcus vasiformis* Tiffany (60)	N. S. Queens, artificial lake
**Tribonema bombycinum* (Agardh) Derb. & Sol. (60)	N. B. Victoria (20)
	N. S. Halifax, boggy ditch
	N. S. Queens, bog
	N. S. Lunenburg, bog

Chrysophyceae

**Chrysosphaerella longispina* Laut. (47)	N. S. Lunenburg, stream
**Dinobryon cylindricum* Imhof	N. B. Charlotte, lake
**D. divergens* Imhof (60)	N. S. Digby, lake
	N. S. Yarmouth, lakes (51)
**D. sertularia* Ehrenb. (60)	N. B. Charlotte, lake
**D. sociale* Ehrenb. (47)	N. B. Charlotte, lake
D. stipitatum Stein (60)	N. B. Charlotte, lake
	N. S. Yarmouth (51)
**Mallomonas caudata* Iwanoff (60)	N. B. Charlotte, lake
**Synura uvella* Ehrenb. (60)	N. B. Charlotte, lake
	N. S. Queens, river

CHLOROPHYTA

Chlorophyceae

VOLVOCALES

Chlamydomonas communis (synonymy uncertain)	N. B. Charlotte (28)
Ch. globosa Snow	N. B. Charlotte (28)
Gonium pectorale Muell.	N. B. Charlotte (28)
**Pandorina morum* Bory (60)	N. S. Hants, pond
	N. S. Queens, artificial lake
	P. E. I. Queens, pond
Sphaerella lacustris (Girod.) Wittr.	N. B. Charlotte (28)
(syn. *Haematococcus pluvialis*)	N. B. Victoria (20)
Volvox globator L.	N. B. Charlotte (28)

CHLOROCOCCALES

Characiaceae

Characium ambiguum Hermann	N. B. Charlotte (28)
Ch. pringsheimii A. Braun	N. B. Charlotte (28)
**Ch. stipitatum* (Bachmann) Wille (47)	N. S. Digby, lake
	N. S. Yarmouth, lake (51)

Protosiphonaceae

Protosiphon botryoides (Kuetz.) Klebs	N. B. Victoria (20)

Chlorococcaceae

Chlorococcum humicola (Kuetz.) Rabenh.	N. B. Victoria (20)
**Golenkinia paucispina* W. & G. S. West (47)	N. S. Hants, pond
Trebouxia cladoniae (Chod.) G. M. Smith	N. B. Victoria (20)

Coelastraceae

**Coelastrum cambricum* Archer (47) N. S. Lunenburg, lake

**C. chodati* Ducellier (12, 41, 46)
Plate III, Fig. 9 N. S. Halifax, lake

This species, originally reported by Ducellier from Switzerland, has since been recorded as *C. augustae* Skuja var. *armatum* Skuja by Skuja from Latvia and by Prescott and Croasdale from Massachusetts. A comparison of the published dimensions follows:

	Ducellier	Skuja	Prescott and Croasdale	Hughes
Coenobium diameter.	50-70μ	ca.60μ	52μ (with spines)	75-90μ (with spines) 50-60μ (without spines)
No. of cells per coenobe.....	26-32	ca.60	ca.30 (see fig.)	ca. 64—ca. 128
Diameter of cells....	8.5-11.5μ	6-8μ	11.5μ	5-8μ
Length of spines.....	10μ (*rare* 13μ)	9μ	6.5μ	7-10μ

Each cell of the author's material appears to have an axial stellate chromatophore with a central pyrenoid, a feature not previously reported for this genus. Before committing himself further, the author would prefer to examine material from other sources.

**C microporum* Naeg. (47) N. B. Charlotte (28)
N. S. Yarmouth (51)
P. E. I. Queens, ponds

C. proboscideum Bohlin N. B. Charlotte (28)

Hydrodictyaceae

**Pediastrum araneosum* Racib. (47) N. B. Charlotte, lake
N. S. Yarmouth, lake (51)

P. araneosum var. *rugulosum* (G. S. West) G. M. Smith N. S. Yarmouth, lake (51)

**P. boryanum* (Turp.) Menegh. (47) N. B. Charlotte, lakes
N. S. Halifax, ponds, lakes
N. S. Hants, pond
N. S. Lunenburg, lake
N. S. Queens, lake
N. S. Yarmouth, lake
P. E. I. Queens, ponds

**P. duplex* Meyen (47)	N. S. Halifax, ponds
	N. S. Lunenburg, lake
	P. E. I. Queens, pond
**P. duplex* var. *rotundatum* Lucks (47)	N. S. Hants, pond
**P. tetras* (Ehrenb.) Ralfs (47)	N. B. Charlotte (28)
	N. S. Halifax, lake, pond
	N. S. Hants, pond
	P. E. I. Kings, pond
	P. E. I. Queens, ponds
**Sorastrum americanum* (Bohl.) Schmidle (60)	N. B. Charlotte, lake
S. spinulosum Naeg.	N. B. Charlotte (28)
Oocystaceae	
**Ankistrodesmus falcatus* (Corda) Ralfs (47)	N. B. Charlotte (28)
(Syn. *Raphidium falcatum*)	N. S. Halifax, lake
	N. S. Hants, pond
	N. S. Lunenburg, stream
	P. E. I. Queens, ponds
**A. falcatus* var. *mirabilis* (W. & G. S. West) G. S. West	N. S. Hants, pond
	P. E. I. Queens, ponds
**A. spiralis* (Turner) Lemm.	N. S. Halifax, pond
	N. S. Hants, pond
**Dictyosphaerium pulchellum* Wood. (47)	N. B. Charlotte, lakes (28)
	N. S. Queens, bog pools
	N. S. Yarmouth, lake (51)
**Dimorphococcus lunatus* A. Braun (47)	N. S. Hants, pond
Eremosphaera viridis deBary	N. B. Charlotte (28)
**Glaucocystis nostochinearum* Itzigs. Smith (49) states that there is only one species in this genus. Our specimens are much more elliptical than those figured by Smith and agree better with Pascher's drawing (37).	N. S. Queens, artificial lake
**Golenkinia paucispina* W. & G. S. West (47)	N. S. Hants, pond
Kirchneriella lunaris (Kirchner) Moebius	N. B. Charlotte (28)
K. obesa (W. West) Schmidle	N. S. Yarmouth (51)
Nephrocytium agardhianum Naeg.	N. B. Charlotte (28)

**Oocystis solitaria* Wittr. (47)	N. B. Victoria (20) N. S. Halifax, swamps N. S. Queens, bog
**Selenastrum bibraianum* Réinsch (47)	N. B. Charlotte, lake
**S. gracile* Reinsch (47)	N. B. Charlotte, lake
S. minutum (Naeg.) Coll.	N. B. Charlotte (28)
**S. westii* G. M. Smith	P. E. I. Queens, pond
Tetraedron minimum (A. Br.) Hansgirg	N. B. Charlotte (28)
Scenedesmaceae	
**Crucigenia irregularis* Wille	N. B. Charlotte, lake
**Scenedesmus abundans* (Kirchner) Chodat	P. E. I. Queens, pond
Sc. armatus (Chodat) G. M. Smith	N. B. Victoria (20)
Sc. bijuga (Turp.) Lagerh.	N. B. Charlotte (28)
Sc. dimorphus (Turp.) Kuetz.	N. B. Victoria (20)
**Sc. obliquus* (Turp.) Kuetz. (47)	N. B. Charlotte (28) P. E. I. Queens, pond
**Sc. quadricauda* (Turp.) Bréb. (47)	N. B. Charlotte (28) P. E. I. Queens, pond
Sc. quadricauda var. *abundans* Kirchner	N. B. Charlotte (28)
Sc. quadricauda var. *horridus* (Kirchner	N. S. Halifax (5)
**Sc. quadricauda* var. *quadrispina* (Chodat) G. M. Smith (47)	N. S. Halifax, pond
SIPHONALES	
Vaucheriaceae	
**Vaucheria pachyderma* Walz (22) This material was previously misidentified by the author as *V. borealis* Hirn and is so listed in his unpublished dissertation.	N. S. Pictou, brook, 9 July, 1941
**V. geminata* De Candolle em. Walz (22) Much of the material in the author's collection belongs in the now. unrecognized var. *racemosa* Walz. The unusual proliferation of the fruiting branch seems worthy of note. Frequently an oogonium is replaced by an additional fruiting branch perpendicular to the main stipe.	N. B. Victoria (20) N. S. Hants, Brook, 14 July, 1941

w. veg. fil. 90-147μ
w. oog. 80-90μ
1. oog. 90-96μ

**V. hamata* Walz (22)	N. S. Pictou, brook, 9 July, 1941
**V. sessilis* De Candolle (22)	N. B. Victoria (20) P. E. I. Kings, marshy ground, 1 Sept., 1939
V. terrestris (Vauch.) De Candolle (syn. *V. terrestris* Lyngb. em. Walz?)	N. B. Victoria (20)
**V. uncinata* Kuetz. w. veg. fil. 48-86μ; oog. 64-74μ x 74-94μ. The identification is based on descriptions by Brown (7), Heering (22), and Hoppaugh (23). The material exhibits variations not mentioned in these works, viz. long fruiting branches (up to 500μ), terminal sex organs, branched fruiting stipes, et al.	N. S. Halifax, marshy ground, 20 July, 1939

TETRASPORALES

Coccomyxaceae

Elakatothrix americana Wille	N. B. Charlotte (28)

Palmellaceae

Gloeocystis confluens (Kuetz.) Richt.	N. B. Victoria (20)
Urococcus insignis Berk & Hass.	N. B Victoria (20)
U. hookerianus Berk. & Hass.	N. B. Victoria (20)

Tetrasporaceae

Apiocystis brauniana Naeg.	N. B. Victoria (20)
**Gloeochaete wittrockiana* Lagerh. (49)	N. S. Queens, lake N. S. Kings, lake
Tetraspora gelatinosa (Vauch.) Desv.	N. B. Victoria (20)

ULOTRICHALES

Chaetophoraceae

**Aphanochaete repens* A. Braun (61)	N. S. Queens, artificial lake
**Chaetonema ornatum* Transeau (65) Originally discovered by Transeau in Alabama, this bi-spinate species has been found epiphytic upon *Tetraspora* sp. and *Draparnaldia platyzonata*.	N. S. Halifax, brook N. S. Queens, river

Chaetophora attenuata Hazen	N. B. Charlotte (28)
Ch. elegans (Roth) Agardh	N. B. Victoria (20)
**Ch. pisiformis* (Roth) Agardh (21)	N. S. Hants, brook
**Draparnaldia platyzonata* Hazen (21)	N. B. Charlotte (28)
	N. S. Halifax, stream
	N. S. Lunenburg, stream
D. plumosa (Vauch.) Agardh	N. B. Victoria (20)
**Stigeocolonium aestivale* Hazen (21)	P. E. I. Kings, stream
S. lubricum (Dillw.) Kuetz.	N. B. Victoria (20)
**S. stagnatile* Hazen (21)	N. S. Queens, pool
Microsporaceae (21, 22)	
**Microspora amoena* (Kuetz.) Rabenh.	P. E. I. Kings, brook
	P. E. I. Queens, brook
**M. floccosa* (Vauch.) Thuret	N. S. Queens, boglake
**M quadrata* Hazen	N. S. Halifax, stream
**M. stagnorum* (Kuetz.) Lagerh.	N. B. Victoria (20)
	N. S. Halifax, bogs
**M. tumidula* Hazen	N. S. Halifax pond, lake
M. wittrockii (Wille) Lagerh.	N. B. Victoria (20)
Protococcaceae	
Protococcus viridis Agardh.	N. B. Victoria (20)
Trentepohliaceae	
Trentepohlia aurea (L.) Martius	N. B. Victoria (20)
Ulotrichaceae (21, 22)	
Stichococcus subtilis (Kuetz.) Klerck	N. B. Victoria (20)
* *Ulothrix tenerrima* Kuetz.	P. E. I. Queens, brook
U. variabilis Kuetz.	N. S. Halifax, pool
U. zonata (Web. & Mohr) Kuetz.	N. B. Victoria (20)
ULVALES (22)	
Schizomeridaceae	
**Schizomeris leibleinii* Kuetz.	P. E. I. Queens, brook
Ulvaceae	
**Enteromorpha intestinalis* (L.) Greville	N. S. Hants, pond
This species was found in quantity on reddish soil in a stagnant pasture pool in the gypsum sink region just north of the Ste. Croix River near Windsor, N. S.	
CLADOPHORALES	
Cladophoraceae	
C. glomerata (L.) Kuetz.	N. B. Victoria (20)

*C. *kuetzingiana* Grunow — P. E. I. Kings,river

*Rhizoclonium *hieroglyphicum* (Agardh) Kuetz. — P. E. I. Queens, lake

OEDOGONIALES (10, 17, 58, 62)

Oedogoniaceae†

*Bulbochaete *citr formis* Hughes (24) — N. S. Queens
11 July, 1941
5 July, 1942

*B. *elatior* Pringsheim — N. S. Queens, pool July 11, 1941
w.v.c. 10-15μ; l.v.c. 45-80μ; w. oog. 46μ; 1. oog. 38μ; w. androsp. 14μ; 1. androsp. 10μ.

*B. *furberae* Collins — N. S. Queens
w.v.c. 8-16μ; w. oog. 35-38μ; — N. S. Kings, pond
l. oog. 29μ-30μ. 5 July, 1942
27 June, 1942

*B. *granulata* Hughes (24) — N. S. Queens
11 July, 1941
5 July, 1942

B. *rectangularis* Wittrock — N. B. Charlotte (28)

*B. *suberecta* (Collins) Tiffany (59) — N. S. Hants, pond
13 July. 1941

*B. *wailesii* Hughes (24) — N. S. Queens
11 July 1941
5 July, 1942

*B. *woronichini* Tiffany (59) — N. S. Queens
w.v.c. 9-16μ; l.v.c. 32-83μ; l. spines 640μ (+); oosp. 32 x 38μ, filling oogone; androsporangia 10-16μ x 9-16μ; dwarf male 9 x 16μ. (Plate 4, Fig. 1). 11 July, 1941
This material agrees very well with Tiffany's description of the species, previously reported only from the Russian Caucasus.

*Oedogonium *armigerum* Hirn — N. S. Queens
w.v.c. 10μ; l.v.c. 67-70μ; oog. 35 x 38μ; oosp. 32 x 32μ. Plate IV, Fig. 4. 11 July, 1941
No antheridia or dwarf males

†All of the species of *Oedogonium* and *Bulbochaete* reported from Queens County were found in a small artificial lake formed by damming of the Medway River, north of Charleston.

were seen. There is, however, no macrandrous species with an echinate oospore and superior pore. Assuming the material to be nannandrous, it agrees best with Tiffany's description of *Oe. armigerum.*

**Oe. acrosporum* de Bary — N. S. Queens 11 July, 1941
w.v.c. 9-13μ (16μ); w. oog. 35-42μ l. oog. 48-54μ; w. oosp. 35-36μ; l. oosp. 45-50μ; anth. 6 x 11μ; dw. male stipe 8 x 22μ.

**Oe. borisianum* (leClerc) Wittr. — N. S. Halifax, pond 13 July, 1941
w.v.c. 14-16μ; w. oog. 42-46μ; l. oog. 42-80μ; w. oosp. 38-42μ; l. oosp. 42-54μ; dwarf male 9.6-13.8μ x 48-57.6μ; w. anth. 6.4μ. Plate 4, Fig. 5.

**Oe. boscii* Kuetz. fa. *dispar* Hirn — N. S. Kings, pond 27 June, 1942

**Oe. braunii* Kuetz. — N. S. Queens 11 July, 1942
w.v.c. 14-16μ; l.v.c. 48-80μ; w. oog. 30-35μ; l. oog. 32-38μ; d. oosp. 30μ; suff. cell. 17 x 57μ; dwarf male 6.5 x 32μ; w. anth. 5μ.

**Oe. crispum* (Hass.) Wittr. — N. B. Charlotte (28) N. S. Hants
w.v.c. 12-16μ; w. oosp. 35-44μ x 38-48μ; w. anth. 11μ; l. anth. 6.4μ.
The Hants material approaches fa. *inflatum* Hirn.

**Oe. gallicum* Hirn. — N. S. Queens 11 July, 1941
w.v.c. 14-16μ; l.v.c. 80-112μ; oog. 41 x 55μ; oosp. 35 x 35μ; dwarf male 7 x 32μ. Plate IV, Fig. 3.

**Oe. gracilius* (Wittr.) Tiffany — P. E. I. Kings, pond 25 Aug. 1939
w.v.c. 16-22μ; l.v.c. 40-70μ; w. oog. 42μ; l. oog. 54μ; oosp. globose, d. 38μ, or ovoid 35 x 39-48μ; anth. w. 21μ; anth. l. 6-7μ.

**Oe. macrandrium* Wittr. var. *hohenackerii* (Wittr.) Tiffany — N. S. Halifax, lake

w.v.c. 11-14μ; l.v.c. 25-38μ; w. oog. 37μ; l. oog. 39μ; d. oosp. 32-34μ; dwarf male max. w. 9.6-11μ; dwarf male l. 30-32μ; w. anth. 6.5μ; l. anth. 5-6μ.
In this material, the oogonia are not as globose as shown in Tiffany's drawings. The anterior end of the oogonium (with rings) is somewhat elongated.
26 July, 1939

**Oe. regium* Hughes (24)
N. S. Queens
11 July, 1941

**Oe. rugulosum* Nordst.
w.v.c. 4-6μ; d. oog. 18μ; d. oosp. 16μ; dwarf males 5 x 16μ, epiphytic on *Oe. borisianum*.
N. S. Halifax, pond
13 July, 1941

**Oe. sexangulare* Cleve
w.v.c. 9-19 (25)μ; l.v.c. 38-46μ; w. oog. 27-38μ; l. oog. 32-41μ; w. dwarf male 6.4-9μ; l. dwarf male 28μ; w. anth. 6.5-9μ; l. anth. 13μ.
The size range of this material is greater than that recorded by Tiffany.
P. E. I. Kings, pond
31 Aug., 1939

Oe. undulatum (Breb.) A. Braun fa.
N. S. Halifax (5)

**Oe. zehneri* Tiffany var. *pyriforme* var. nov. (59)
Varietas oogoniis pyriformibus; extremis distalibus oogoniorum angustioribus; oosporis late ellipsoideis, oogonia non complentibus; crass. cell. veg. 10-13μ; crass. oog. 42μ; long. oog. 61μ; crass. oosp. 38μ; long. oosp. 42μ; crass. cell. suff. 22.4μ; alt. cell. suff. 58μ; crass. nann. 7μ; long. nann. 35μ. Plate IV, Fig. 2. Variety with pyriform oogonia, narrow ends distal; oospores broadly ellipsoid, not filling the oogonia.
N. S. Queens
11 July, 1941

ZYGNEMALES†

Zygnemataceae (66)

**Mougeotia recurva* (Hass.) de Toni	N. S. Kings, lake 28 June, 1942
**M. virescens* (Hass.) Borge	N. S. Halifax, pond 14 July, 1941
**Spirogyra communis* (Hass.) Kuetz. w.v.c. 19μ; cross walls plane; chrom. one with 2.5-3 turns; conj. scalariform; tubes about equal in size; zygospores ellipsoid, smooth, w. 22μ, l. 42-48μ.	N. S. Halifax, swamp 13 July, 1941
**Sp. inflata* (Vauch.) Rabenh. w.v.c. 16μ; cross walls replicate; chrom. one with ca. 2.5 turns. conj. scalariform; both gametangia inflated; zygospores w. 25-28μ; l. 50-70μ.	N. S. Halifax, lake 26 July, 1939
**Sp. lambertiana* Transeau w.v.c. 30-35μ; l.v.c. 200-350μ; cross-walls replicate; chrom. one with 4.5 turns; conj. scalariform; zygospores ellipsoid, yellowish-brown; outer mesospore wrinkled; inner mesospore reticulate; zyg. w. 35-44μ; l. 80-87μ.	N. S. Hants, pool 29 July, 1939
**Sp. minutifossa* Jao w.v.c. 16μ; l.v.c. 64-176μ; cross walls plane; chrom. one with 2.5-5 turns; conj. lateral; zygospores ellipsoid, w. 23-26μ, 1.38-45μ; mesospore yellowish brown to brown, finely reticulate. This species has been previously reported only from Massachusetts. The minor differences in type of conjugation and spore characters do not seem great enough to warrant varietal or specific status for the Nova Scotian material.	N. S. Queens, artificial lake 11 July, 1941

†In his doctoral dissertation, the author inadvertently listed *Mougeotia quadrangulata* Hass., *Spirogyra laxa* Kuetz., and *S. tenuissima* (Hass.) Kuetz. as occurring in his maritime collections. The species mentioned were found in Ontario.

Sp. sirogonioides Hughes (24) — N. S. Queens, artificial lake 11 July, 1941 5 July, 1942

Zygogonium ericetorum Kuetz. — N. S. Queens, artificial lake 11 July, 1941 5 July, 1942

Entransia fimbriata Hughes (24) The systematic position of this genus (found in a sterile condition) is uncertain. — N. S. Queens, artificial lake 11 July, 1941

DESMIDIALES

Desmidiaceae

Arthrodesmus bulnheimii Racib. (25) — N. S. Lunenburg, stream

A. convergens Ehrenb. (25) — N. S. Hants, pond; N. S. Kings, lake

A. incus (Bréb.) Hass. — N. S. Yarmouth, lake (51)

A. incus var. *extensus* Anderson (25) — N. S. Hants, pond; N. S. Halifax, pond; N. S. Kings, lake; N. S. Lunenburg,lake. stream

A. quadridens Wood (25) — N. S. Halifax, pond

A. octocornis Ehrenb. (25) — N. B. Northumberland (1, 2); N. S. Queens, artificial lake; N. S. Hants, pond

A. triangularis Lagerh. (25) — N. S. Yarmouth, lakes (51)

A. triangularis var. *subtriangularis* (Borge) W. and G. S. West (25) — N. S. Yarmouth, lake

A. triangularis var. *rotundatus* (Racib) G. M. Smith (48) — N. B. Charlotte, lake

Closterium abruptum W. West (29) Max. w. 14-16μ; w. ap. 6.4-8μ; l. 121-154μ. Plate I, Fig. 6. — N. S. Halifax, ponds & bogs

Cl. acerosum (Schrank) Ehrenb. — N. B. Northumberland (1)

Cl. acerosum var. *augustius* var. nov. Varietas angustior quam typus longiorque in proportione ad latitudinem; apicibus aliquantulum recurvatis; membranis laevibus aut nonnunquam punctulis minutissimis vix visibilibus et in ordinibus longitudinalibus dispositis. Lat. max. 16-21μ; Lat. apic. 4-5μ; — P. E. I., Kings, marshy pasture at Cardigan. Collection No. 46.

Long. 350-418μ. Plate I, Fig. 4. Variety narrower than type and longer in proportion to width. Apices very slightly recurved. Wall smooth or sometimes with very fine punctae arranged in scarcely visible longitudinal lines.	
Cl. acutum Bréb.	N. B. Northumberland (1)
Cl. acutum var. *tenuius* Nordst. (syn. *Cl. subtile* Bréb.)	N. B. Northumberland (1)
**Cl. angustatum* Kuetz. (29)	N. S. Halifax, ponds and bogs
Max. w. 22-26μ; w. ap. 16μ; l. 260-333μ.	N. S. Hants, pond N. S. Lunenburg, stream
**Cl. angustatum* var. *annulatum* var. nov. Utraque semi-cellula varietatis anulo terminale adquem costae junctae sunt. Ceterum ut in typo. Lat. max. 16-26μ; lat. apic. 9-13μ; long. 225-338μ. Plate I, Fig. 2. Each semi-cell of the variety has a terminal annular ridge to which the costae are attached. In other respects the variety resembles type.	N. S. Halifax, pond one mile west of Waverly. Collection No. 171
**Cl. archerianum* Cleve (29)	N. B. Charlotte, lake
max. w. 16-19μ; w. ap. 4μ; l. 200-208μ	N. S. Halifax bog N. S. Yarmouth, lake
**Cl. baillyanum* Bréb. (29)	N. S. Halifax, ponds
max. w. 46μ; w. ap. 17-18μ; l. 416-470μ.	
Cl. braunii Reinsch	N. S. Pictou (26)
Cl. calosporum Wittr.? (see note under *Cl. dianae*)	
**Cl. costatum* Corda (29)	N. B. Charlotte, lake
Max. w. 50μ; w. ap. 16μ; l. 384μ.	N. B. Northumberland (1, 2) N. S. Halifax, pond, lake N. S. Lunenburg, stream
Cl. costatum var. *subcostatum* (Nordst.) Krieger (syn. *Cl. subcostatum* Nordst.)	N. B. Northumberland (1, 2)

**Cl. costatum* var. *westii* Cushman (29)	N. B. Charlotte, lake
Max. w. 22-32μ; w. apices 6.5-10μ; l. 260-310μ.	N. S. Queens, artificial lake
Specimens with a slight median tumescence were found in the Charlotte and Halifax collections. The swelling was not considered sufficient to warrant identification as Raciborski's var. *subtumidum*.	N. S. Halifax, pond
**Cl. cynthia* de Not. (29)	N. S. Halifax, ponds, lake
**Cl. cynthia* var. *jenneri* (Ralfs) Krieger (23)	N. S. Pictou, lake
max. w. 9.6μ; w. apices 4.8μ; l. 106μ.	
**Cl. dianae* Ehrenb. (29)	N. B. Northumberland (1, 2)
It is impossible to separate *Cl. calosporum* and *Cl. dianae* in the vegetative condition. Since no zygospores were found, either one or both of the species may occur in the author's collections.	N. S. Halifax, pond, lake
	N. S. Hants, brook
	N. S. Lunenburg, lake
**Cl. dianae* var. *brevius* (Wittr.) Petkoff (29)	N. S. Halifax, pond
max. w. 20μ; l. 131μ; Plate I, Fig. 1.	N. S. Lunenburg, stream
**Cl. dianae* var. *pseudodianae* (Roy) Krieger (29)	N. S. Halifax, bog
**Cl. didymotocum* Corda (29)	N. B. Northumberland (1)
	N. S. Halifax, ponds
	N. S. Yarmouth, lake
**Cl. ehrenbergii* Menegh. (29)	N. S. Halifax, ditch
	N. S. Queens, artificial lake
**Cl. ehrenbergii* var. *malinvernianum* (De Not.) Rabenh.	P. E. I. Kings, marsh
w. 35.4μ; l. 224.2μ. Plate I, Fig. 5. As indicated in the figure, the median region of our specimens is finely striate, the striate intergrading into parallel rows of minute punctae. The major part of the cell wall except for the tip is, however, finely but irregularly punctate. Girdle-bands were seen in some specimens.	

**Cl. gracile* Bréb. (29)	N. B. Northumberland (1) N. S. Halifax, pond N. S. Yarmouth, lake (51)
**Cl. gracile* var. *elongatum* W. and G. S. West (29)	N. S. Halifax, pond
**Cl. intermedium* Ralfs (29) max. w. 15-22μ; w. ap. 6.4-9μ; l. 166-256μ.	N. S. Halifax, pond, bogs N. S. Yarmouth, lake (51)
Cl. juncidum Ralfs	N. B. Northumberland (1)
**Cl. kuetzingii* Bréb. (29) max. w. 15-19μ; w. ap. 3-4μ; l. 375-500μ.	N. B. Charlotte, lake N. S. Halifax, pond N. S. Lunenburg, streams N. S. Queens, lake
**Cl. lagoense* Nordst. (29) fa. max. w. 42μ; w. ap. 6.5μ; l. 448μ. The plants are much larger and apices of the cells are not swollen as much as indicated by Krieger.	N. B. Charlotte, lake
Cl. lanceolatum Kuetz.	N. B. Northumberland (1)
Cl. leibleinii Kuetz. (syn. *Cl. acuminatum*)	N. B. Northumberland (1)
**Cl. libellula* Focke (29) (syn. *Penium closterio des* Ralfs) max. w. 75-80μ; w. ap. 19μ; l. 495-512μ. Dimensions larger than those recorded by Krieger, but the proportions are the same.	N. B. Northumberland (1) N. S. Halifax, ditch
**Cl. lineatum* Ehrenb. (29)	N. B. Northumberland (1) N. S. Kings, lake
Cl. lunula (Muell.) Nitzsch	N. B. Northumberland (1)
Cl. lunula var. *coloratum* Klebs (syn. var. *striatum* Wolle)	N. B. Northumberland (1)
**Cl. macilentum* Bréb. (29) w. 9.6-16μ; w. ap. 6-6.4μ; l. 341μ-511μ. Some of the Halifax specimens have brownish walls but they do not fit into the size range given for the var. *coloratum* Elenkin & Lobik.	N. B. Northumberland (1) N. S. Halifax, pond Lunenburg, lake N. S. Yarmouth, lake
**Cl. moniliferum* (Bory) Ehrenb.	N. B. Charlotte, lake N. S. Colchester, stream N. S. Halifax, pond N. S. Hants, pond N. S. Kings, ditch

Cl. nasutum Nordst. — N. B. Northumberland (1)

Cl. navicula (Bréb.) Luetkem. (syn. *Penium navicula* Breb.) — N. B. Northumberland (1)

**Cl. parvulum* Naeg. (29) — N. B. Northumberland (1, 2); N. S. Halifax, lake (5)

**Cl. pritchardianum* Archer (29) — N. S. Halifax, pond

**Cl. pronum* Bréb. (29) — N. S. Halifax, lake

**Cl. ralfsii* Bréb. (syn. *Cl. decorum* Breb.) (29) — N. B. Northumberland (1); N. S. Halifax, pond; N. S. Yarmouth, lake

**Cl. ralfsii* var. *hybridum* Rabenh. — N. S. Yarmouth, lak' (51)

**Cl. rostratum* Ehrenb. (29) — N. S. Hants, brook

**Cl. setaceum* Ehrenb. (29) — N. S. Halifax, pond; N. S. Lunenburg, stream; N. S. Yarmouth, lake (51)

max. w. 9-11μ; w. ap. 2μ; l. 285-292μ.

In some of the Halifax specimens, girdle-bands were present.

**Cl. setaceum* var. *elongatum* W. and G. S. West — N. S. Halifax, bog; N. S. Lunenburg, stream

Krieger (29) states that the cells of this variety are 50 to 65 times as long as broad. The Nova Scotian specimens, with a length-width ratio of 44 to 47, agree better with Krieger's illustration.

Cl. strigosum Bréb. — N. B. Northumberland (1, 2)

**Cl. striolatum* Ehrenb. (29) — N. S. Halifax, ponds, ditch

max. w. 19-41μ; w. ap. 6-14μ; l. 200-368μ.

**Cl. subjuncidiforme* Groenblad — N. S. Halifax, lake

max. w. 16μ; w. apices 10-11μ; l. 390μ. Plate I, Fig. 3.

The L/W ratio of Groenblad's original Finnish specimens is much lower than that of our material. Krieger (29), however, mentions narrower Silesian plants (w. 10μ). The costae in the Halifax specimens become somewhat spirally arranged near the apices, a feature not reported by Groenblad. Since the latter author includes both

straight and spiral costae in *Cl. subscoticiforme*, it seems justifiable to follow the same practice with *Cl. subjuncidiforme*.

**Cl. toxon* W. West max. w. 8μ; w. apices 4.8μ; l. 246μ. Plate I, Fig. 7.	N. S. Lunenburg, lake, stream
**Cl. turgidum* Ehrenb. (29) w. 61-64μ; w. ap. 16-19μ; l. 704-880μ. The specimens from one pond seem to be intermediate between this species and *Cl. pritchardianum* which occurs in the same collection.	N. S. Halifax, ponds
**Cl. ulna* Focke (29) max. w. 9-16μ; w. ap. 7-10μ; l. 240-300μ.	N. S. Halifax, lake, bog
**Cl. venus* Kuetz. (29)	N. B. Northumberland (1, 2) P. E. I. Queens, pond
**Cl. venus* var. *incurvum* (Bréb.) Krieger (29)	P. E. I. Queens, pond
Cosmarium abscissum Luetke. (syn. *Penium truncatum* Bréb.)	N. B. Northumberland (1)
**C. angulosum* Bréb. (70)	P. E. I. Queens, pond
**C. amoenum* Bréb. (25)	N. S. Queens, brook
**C. bipunctatum* Borg. (25)	N. S. Queens, pond
C. botrytis (Bory) Menegh.	N. B. Northumberland (1) N. S. Halifax (5)
C. botrytis var. *subtumidum* Wittr.	N. S. Pictou (26)
**C. boeckii* Wille (25)	N. S. Halifax, pond N. S. Kings, ponds, stream
C. brebissonii Menegh.	N. B. Northumberland (1)
**C. calcareum* Wittr. var. *minor* W. and G. S. West (70)	N. S. Halifax, pond
C. circulare Reinsch	N. B. Northumberland (1)
C. conspersum Ralfs	N. B. Northumberland (3)
**C. contractum* Kirch.	N. B. Charlotte, lake N. B. Northumberland (1) N. S. Queens, pond N. S. Yarmouth, lake (51)
**C. cosmetum* W. and G. S. West (69)	N. S. Lunenburg, lake
**C. crenatum* Ralfs (70)	N. S. Queens, pond

C. crenatum var. *bicrenatum* Nordst. (70) — N. S. Pictou (26)

**C. cucurbita* Breb. (25) — N. S. Queens, bog

C. debaryi Archer — N. B. Northumberland (1)

**C. difficile* Luetke (70) — N. S. Halifax, pond

**C. difficile* var. *sublaeve* Luetke. (70) — N. S. Halifax, pond

**C. eloisianum* Wolle var. *depressum* W. and G. S. West (25) — N. S. Lunenburg, lake

**C. eloisianum* var. *scrobiculatum* var. nov. — N. S. Halifax, pond, Collection No. 171.

A fronte in media membrana semicellularum, aliquot granulis polygonis complanatisque a liris adjunctis. Inter granula et liras scrobiculae polygonae sunt. Ceterum ut in typo.

Lat. 80μ; isth. 22.4μ; Long. 109μ.

Plate II, Fig. 10.

In face view the central area of the wall of each semi-cell bears several flattened polygonal granules or prominences which are joined to each other by ridges surrounding polygonal depressions. Sometimes the ridges appear to be radially arranged around the prominences but at other times the arrangement of prominences, depressions, and ridges is irregular. Other features of the variety are the same as in the type. The prominences and ridges are yellowish brown in color.

**C. granatum* Bréb. (25) — N. S. Halifax, ponds; N. S. Lunenburg, lake

**C. hammeri* Reinsch — N. S. Hants, pond

C. hammeri var. *homalodermum* (Nordst.) W. and G. S. West (syn. *C. homalodermum* Nordst.) — N. B. Northumberland (1)

**C. impressulum* Elfv. (25, 55) — N. S. Hants, pool; P. E. I. Queens, pond

The size of the cells in the Hants collection is smaller than type.

w. 17μ; isth. 6-7μ; l. 17μ.

**C. isthmium* W. West	N. S. Queens, river
**C. isthmium* fa. *hibernicum* W. West (25) w. 30-35μ; l. 51-54μ; isth. 18-19μ. Plate II, Fig. 9.	N. S. Halifax, pond
**C. isthmochondrum* Nordst. (70)	N. S. Halifax, pond
C. laeve Rabenh.	N. B. Northumberland (1)
C. margaritatum (Lund.) Roy and Biss. fa. *minor* (Boldt) W. and G. S. West (25)	N. S. Kings, pond
**C. monomazum* Lund. var. *polymazum* Nordst. (25)	N. B. Charlotte, lake
**C. moniliforme* (Turp.) Ralfs (25)	
**C. obtusatum* Schmidle (25)	N. S. Cumberland, ditch
**C. ochtodes* Nordst. (70)	N. S. Halifax, pond
**C. ornatum* Ralfs (25)	N. S. Halifax, lake, pond N. S. Hants, brook, bog N. S. Lunenburg, lake N. S. Queens, pond
**C. orthostichum* Lund. (25) w. 29μ; isth. 9.5-11μ; l. 32-34μ.	N. S. Halifax, pond N. S. Queens, artificial lake
**C. ovale* Ralfs (25)	N. B. Northumberland (1) N. S. Halifax, pool
**C. ovale* var. *prescottii* Irénée-Marie (25) Dimensions of our specimens fall well within the range established by Irénée-Marie. w. 106μ; isth. 35.2μ; th. 74μ; l. 192μ;. Plate II, Fig. 12.	N. S. Halifax, pond
**C. panamense* Prescott var. *smithii* var. nov. Plate II, Fig. 11. Cellulis lat. 58-61μ, long. 84-90μ, crass. 42-48μ; isth. 25-27μ. Semicellulis compresso-ovoidis, polis subtruncatis, angulis basalibus rotundatis, sinu lineare extrorsus ampliato; a vertice late ellipticis vel ovoidis; a latere subtriangularibus, polis subtruncatis, angulis basalibus rotundatis; membranis scrobiculatis granulatisque, scrob-	N. B. Charlotte, lake

iculorum ordinibus parallelis porcis perpendicularibus et horizontalibus disjunctis, granulis prominentibus ad decussationibus porcarum.

Collected in the plankton of Potter's Lake, Charlotte County, New Brunswick, by Dr. M. W. Smith after whom the variety is named.

This variety differs from *C. panamense* (39) in size (larger) and in the shape of the semi-cells (surface-view compressed-ovoid, poles sub-truncate, basal angles rounded; lateral view—subtriangular; vertical view—broadly elliptical to ovoid). The surface ornamentation is identical with that of Prescott's species, and is apparently unique for the genus. Type reported from Panama and Louisiana.

C. perforatum	N. B. Northumberland (1)
**C. portianum* Arch. (25)	N. S. Halifax, bog, pond N. S. Hants, ponds
**C. portianum* var. *nephroideum* Wittr. (25)	N. S. Lunenburg, stream
**C. pseudoconnatum* Nordst. (25) syn. *Calocylindrus connatus* (Nordst.) Wolle	N. B. Northumberland (1) N. S. Halifax, river N. S. Lunenburg, stream
**C. pseudonitidulum* Norst. var. *validum* W. and G. S. West (25)	N. S. Hants, pool
**C. pseudopyramidatum* Lund. (25)	N. S. Halifax, pond
C. punctulatum Breb.	N. B. Northumberland (3)
**C. punctulatum* var. *subpunctulatum* (Nordst.) Boerg. (25)	N. S. Halifax, pond
**C. quadratum* Ralfs (25)	N. S. Queens, brook
**C. quadrifarium* Lund. (25)	N. S. Halifax, ponds N. S. Lunenburg, stream
C. quasillus Lund.	N. S. Pictou (26)
**C. quinarium* Lund. var. *hexagonum* var. nov. Plate II. Fig. 8.	N. S. Halifax, pond,

Varietas sine granulis marginalibus. Frontes semi-cellularum decem granulis in duobus hexagonis dispositis. Lat. 48μ; Lat. isth. 15μ; Crass. 31μ; Long. 58μ. A variety without marginal granules. Faces of the semi-cells with ten central granules forming two adjoined hexagons. The plants are larger than type and do not fit Nordstedt's fa. *irregulare* even when the latter is expanded to include Irénée-Marie's material. It is quite possible that the author's material should not be assigned to *C. quinarium*.	Collection No. 171
**C. reniforme* (Ralfs) Arch. (25)	N. S. Halifax, lake, bog N. S. Lunenburg, bog
**C. regnellii* Wille (25)	N. S. Halifax, pond
**C. speciosum* Lund. (25)	
C. subtumidum Nordst.	N. S. Halifax (5) N. S. Yarmouth, lake (51)
C. subtumidum var. *klebsii* (Gut.) W. and G. S. West	N. S. Yarmouth, lake (51)
**C. subspeciosum* Nordst. var. *validius* Nordst. (25) w. 54.4μ; isth. 19.2μ; th. 32μ; l. 70.4μ. The true nature of the crenulations is apparent only in lateral or apical view. Each large granule (varying in shape from circular to square to polygonal) is partially delimited by small granules. When the small granules are strongly developed, the crenulations are bi-granulate in literal view.	N. S. Halifax, pond
**C. sulcatum* Nordst. (68) w. 32μ; isth. 6-7μ; l. 35μ. Plate III, Fig. 4.	N. S. Lunenburg, lake

**C. taxichondrum* Lund. (25) w. 45-60μ; isth. 10-14μ; th. 23-25μ; l. 45-58μ. In our material the number of surface granules varied from 8 to 12.	N. S. Halifax, pond N. S. Lunenburg, stream
**C. taxichondrum* var. *subundatum* Boldt (4) w. 32μ; isth. 9μ; th. 19μ; l. 35μ. Plate II, Fig. 6. Though larger and possessing one more surface granule per semicell, our specimens agree very well with Boldt's description. Laporte (24) reports this variety (misnamed *subundulatum*) from France with no isthmus granule.	N. S. Lunenburg, lake
**C. taxichondrum* var. *unigranulatum* Prescott (38) w. 32-39μ; isth. 10-14μ; th. 19-26μ; l. 41-48μ. Plate II, Fig. 7. Our specimens are slightly smaller than those originally described by Prescott from Michigan.	N. S. Halifax, ditch
C. turpinii Breb. var. *lundellii* Gutw. (included in the type by W. and G. S. West (70))	N. S. Pictou (26)
**C. turpinii* var. *podolicum* Gutw. (25)	N. S. Halifax, ponds
**C. undulatum* Corda (70)	P. E. I. Queens, pond
C. viride (Corda) Joshua syn. *C. cordanum* (Breb.) Rabenh. (70)	N. S. Pictou (26, 49)
**C. venustum* (Breb.) Arch.	P. E. I. Queens, pond
**Desmidium aptogonum* Breb. (25)	N. B. Northumberland (3) N. S. Halifax, pond
**D. aptogonum* var. *acutius* Nordst. (25)	N. S. Halifax, pond N. S. Lunenburg, lake
**D. baileyi* (Ralfs) Nordst. (25)	N. S. Halifax, stream N. S. Lunenburg, stream N. S. Queens, artificial lake N. S. Yarmouth, lake (51)

**D. grevillii* (Kuetz.) de Bary (25)	N. S. Lunenburg, stream
	N. S. Yarmouth, lake (51)
**D. swartzii* Agardh (25)	N. B. Northumberland (1)
	N. S. Halifax, ponds, lake
	N. S. Hants, pond
	N. S. Lunenburg, lake
	N. S. Queens, artificial lake
Docidium baculum Breb.	N. B. Northumberland (1)
D. crenulatum (synonymy uncertain)	N. B. Northumberland (1)
**D. undulatum* Bailey (23)	N. S. Halifax, lake, pond
Euastrum affine Ralfs	N. S. Yarmouth, lake (51)
**Eu. ampullaceum* (23)	N. B. Northumberland (3)
	N. S. Halifax, pond
	N. S. Queens, bog
Eu. ansatum Ehrenb.	N. B. Northumberland (1)
**Eu. binale* (Turp.) Ehrenb. fa. *hians* W. West	N. S. Queens, pond
**Eu. ciastonii* Racib. (29, 25, 43) w. 27μ; isth. 6.5μ; th. 15μ; l. 39μ; depth apical sinus 7μ. Plate II, Fig. 4. The proportions of the specimens agree better with Prescott & Scott (43). The ornamentation is closer to that indicated by Krieger (29) and Irénée-Marie (25).	N. S. Halifax pond
**Eu. crassum* (Brėb.) Kuetz. (29)	N. S. Yarmouth lakes (51)
**Eu. crassum* var. *scrobiculatum* Lund. (23) w. 67μ; isth. 18μ; l. 148μ. Plate III, Fig. 2.	N. S. Queens bog
**Eu. denticulatum* (Kirch.) Gay var. *angusticeps* Groenblad (29, 56) w. 16μ; isth. 4-5μ; th. 14μ; l. 22.4μ. Plate II, Fig. 3.	N. S. Lunenburg, lake
**Eu. didelta* Ralfs (29) max. w. 64-77μ; ap. w. 29-32μ; isth. 16-26μ; depth ap. sinus 6.8-9.6μ; l. 122-160μ. Plate II, Fig. 5.	N. B. Charlotte, lake N. S. Hali ax, bog, pond, lake N. S. Lunenburg, lake N. S. Queens, artificial lake, pond N. S. Yarmouth, lake (51)
**Eu. divaricatum* Lund. (29)	N. S. Queens, bog
**Eu. elegans* (Breb.) Kuetz. (29)	N. B. Charlotte, lake

**Eu. gemmatum* Breb. (29)	N. S. Halifax, lake N. S. Lunenburg, lakes
Eu. humerosum Ralfs	N. B. Northumberland, (1, 3)
**Eu. humerosum* var. *parallelum* Krieger (29) max. w. 54.4μ; w. ap. 22.4μ; isth. 16μ; depth ap. sinus 8μ; l. 115μ. Krieger gives no dimensions for this variety which was described first by Borge from Sweden.	N. B. Charlotte, lake
**Eu. insigne* Hass. (29) max. w. 54-70μ; ap. w. 26-32μ; isth. 16-16μ; l. 102-134μ.	N. S. Halifax, pond, lake N. S. Queens, bog
**Eu. lapponicum* Schmidle (29)	N. S. Halifax, lake
**Eu. montanum* W. and G. S. West (29)	N. S. Halifax, ditch N. S. Queens, bog
**Eu. oblongum* (Grev.) Ralfs (29) max. w. 64-67μ; isth. 19-23μ; l. 144-148μ. According to Irénée-Marie (25) in *Eu. oblongum* "les lobes du chaque côté du lobe polaire sont rectangulaires" while in *Eu. humerosum* "les lobes moyens sont arrondis et non rectangulaires." Some of the specimens in one of the Halifax ponds have rounded lobes and are much shorter in relation to length than *Eu. oblongum*. Although the measurements agree more closely with *Eu. humerosum*, the total aspect of the cells is more like *Eu. oblongum*. Dimensions of one of the latter plants follow: w. 74μ; isth. 19μ; l. 119μ.	N. S. Halifax, ponds
**Eu. pinnatum* Ralfs (29)	N. B. Northumberland (1) N. S. Halifax, pond N. S. Queens, bog N. S. Yarmouth, lake (51)
**Eu. sinuosum* Lenorm. var. *germanicum* (Racib.) Luetke. (29) max. w. 37-42μ; w. ap. 19μ; isth. 9-10μ; th. 22-26μ; l. 74μ. Plate III, Fig. 3.	N. S. Lunenburg, lake

Differs from the variety in the presence of an apical pore on each "Anschwellung."	
**Eu. sinuosum* var. *reductum* W. and G. S. West (29) max. w. 29μ; w. ap. 16μ; isth. 7μ; th. 19μ; depth ap. sinus 10μ; l. 50μ. Plate III, Fig. 1. My figure is intermediate between Krieger's and Prescott's (43).	N. S. Halifax, pond
**Eu. verrucosum* Ehrenb. (29) max. w. 58-67μ; isth. 15-16μ; th. 37μ; l. 67-80μ.	N. B. Charlotte, lake N. B. Northumberland (1, 2) N. S. Halifax, pond N. S. Hants, pond N. S. Queens, pond
Eu. verrucosum var. *alatum* Wolle (reported by Baxter as var. *elatum*)	N. B. Northumberland 1)
Eu. verrucosum var. *simplex* Joshua Krieger (29) refers this variety to the genus *Cosmarium* but does not say which species.	N. S. Pictou (26)
Eu. urniforme Wolle Krieger (29) excludes this doubtful species from his monograph.	N. B. Northumberland (1)
**Gymnozyga moniliformis* Ehrenb. (25)	N. B. Northumberland (1) N. S. Halifax, pond, lakes N. S. Hants, lake N. S. Kings, lake N. S. Lunenburg, stream, bog N. S. Queens, river, lake N. S. Yarmouth, lakes (51)
**G. moniliformis* var. *gracilescens* Nordst. (25)	N. S. Halifax, lake
** Hyalotheca dissiliens* (Smith) Breb. (25)	N. B. Northumberland (1) N. S. Digby, lake N. S. Hants N. S. Kings, lake N. S. Lunenburg, lake N. S. Queens, pond, river N. S. Yarmouth, lake (51)
H. dissiliens var. *bidentula* Nordst.	N. S. Halifax (5)
H. dissiliens fa. *tridentula* Nordst.	N. S. Pictou (26)

H. dubia (synonymy uncertain) — N. B. Northumberland (1)

**H. mucosa* (Dillw.) Ehrenb. (25) — N. S. Queens, artificial lake; N. S. Yarmouth, lake (51); P. E. I. Kings, pond

**H. neglecta* Racib. (25) — N. S. Halifax, lake
max. w. 10-11μ; ap. w. 8-9μ; l. 39-41μ.
Varies from type by the presence of two pyrenoids per chromatophore.

**Micrasterias americana* (Ehrenb.) Ralfs (29) — N. B. Northumberland (1, 2); N. S. Halifax, pond; N. S. Hants, pond; N. S. Pictou (63)
Krieger includes Turner's var. *spinosa* in type.

M. americana var. *Boldtii* Gutw. (syn. *M. americana* var. *recta* Wolle). — N. B. Northumberland (3)

**M. apiculata* (Ehrenb.) Menegh. (29) — N. B. Northumberland (1); N. S. Cumberland, ditch; N. S. Digby, lake; N. S. Hants, pond

M. brachyptera Lund. — N. B. Northumberland (1)

M. mamillata Turner — N. B. Northumberland (3)
Krieger (29) includes this species in *M. apiculata* type, but it appears to be quite distinct according to Turner's figures. (63)

**M. arcuata* Bailey var. *expansa* (Bail.) Nordst. (29) — N S. Queens, bog

**M. conferta* Lund. fa. — N. S. Halifax, bog
max. w. 99μ; ap. w. 51-57μ; isth. 16μ; l. 105-112μ. Plate I, Fig. 9.
Differs from type (29) in the following respects—cell outline approaching hexagonal; dimensions 10% larger, apical lobes and sub-apical lobes of the second order proportionally wider than type.

**M. denticulata* Bréb. (29) — N B. Northumberland (3); N. S. Halifax, lake; N. S. Queens, lake

**M. fimbriata* Ralfs var. *spinosa* Biss. (29)	N. S. Halifax, pond
M. foliacea Bailey	N. S. Yarmouth, lake (51)
**M. jenneri* Ralfs (29)	N. S. Halifax, bog, ditch
M. laticeps Nordst.	N. S. Yarmouth, lake (51)
**M. mahabuleshwarensis* Hobson var. *dichotoma* (G. M. Smith) Krieger (29)	N. S. Yarmouth, lake
**M. mahabuleshwarensis* var. *ringens* (Bail.) Krieger (29) max. w. 144μ; isth. 19μ; l. 128μ. Plate I, Fig. 10.	N. B. Charlotte, lake
**M. muricata* (Bail.) Ralfs (29)	N. S. Queens, artificial lake N. S. Lunenburg, lake N. S. Yarmouth, lake
M. nordstedtiana Wolle	N. S. Yarmouth, lake (51)
**M. papillifera* Bréb. (29)	N. B. Northumberland (3) N. S. Halifax, pond N. S. Cumberland, ditch
M. papillifera var. *nova-scotiae* Turner (spelling changed by Krieger, 29)	N. S. Pictou (63)
**M. pinnatifida* (Kuetz.) Ralfs (29)	N. S. Halifax, lake N. S. Yarmouth, lake (51)
**M. radiata* Hass. (29)	N. B. Charlotte, lake N. S. Lunenburg, stream N. S. Queens, lake N. S. Yarmouth, lake (51)
**M. radiata* var. *dichotoma* (Wolle) Cush. (29)	N. S. Queens, artificial lake
**M. radiata* var. *gracillima* G. M. Smith (29) max. w. 224μ; isth. 17μ; max. l. 224μ. (incl. arms). Plate I, Fig. 11.	N. S. Yarmouth, lakes (51)
**M. rotata* (Grev.) Ralfs (25)	N. S. Halifax, ditch
M. rotata var. *evoluta* Turner (syn. *M. rotata* var. *simplex* Wolle)	N. B. Northumberland (3)
M. sol (Ehrenb.) Kuetz. (syn. *M. radiosa* Ralfs).	N. B. Northumberland (2)
M. sol var. *ornata* Nordst.	N. S. Yarmouth, lake (51)

**M. thomasiana* Arch. (29) w. 269μ; isth. 25μ.; l. 256μ; Plate I, Fig. 12. Differs from previous descriptions in being shorter than broad.	N. S. Halifax, bog
M. thomasiana var. *notata* (Nordst.) Groenblad (syn. *M. denticulata* var. *notata* Nordst.).	N. S. Halifax (5)
**M. truncata* (Corda) Bréb. (29) One specimen from a Halifax pond agrees with var. *pusilla* G. S. West. Other larger specimens (id. loc.) intergrade with var. *trid entata* Bennett. The author doubts the validity of these varieties.	N. B. Northumberland (3) N. S. Digby, lake N. S. Halifax, bog, lake, pond N. S. Hants, lake N. S. Lunenburg, bog, lake N. S. Queens, bog, brook, artificial lake N. S. Yarmouth, lake (51)
**Onychonema filiforme* (Ehrenb.) Roy and Biss. (25)	N. S. Halifax, stream
**O. laeve* Nordst. var. *micracanthum* Nordst. (25)	N. S. Kings, lake
**Penium cylindrus* (Ehrenb.) Brėb. (29)	N. S. Halifax, pond
**P. margaritaceum* (Ehrenb.) Brėb. (29) (syn. *Closterium decussatum* Kuetz.)	N. B. Northumberland (2, 3) N. S. Halifax, ditch N. S. Yarmouth, lake
**P. rufescens* Cleve (29) w. 26-29μ; isth. 26μ; l. 63-67μ.	N. S. Halifax, pond
**P. spirostriolatum* Barker var. *amplificatum* Schmidt (29) max. w. 19-30μ; w. ap. 12-24μ; l. 145-176μ. Plate II, Fig. 2. In some specimens the striae are not spiral but resemble more closely Krieger's figure of the type species.	N. S. Halifax, lake, pond
**Pleurotaenium coronatum* (Bréb.) Rabenh. (25)	N. S. Lunenburg, lakes N. S. Yarmouth, lake

**Pl. ehrenbergii* (Bréb.) de Bary (25)	N. B. Charlotte, lake
	N. S. Halifax, pond
	N. S. Kings, lake
	N. S. Lunenburg, lake
	N. S. Queens, artificial lake, pond, bog
	N. S. Yarmouth, lake (51)
Pl. eugeneum (Turn.) W. and G. S. West	N. S. Yarmouth, lake (51)
**Pl. nodosum* Bailey (25) max. w. 54μ; w. apex. 28μ; isth. 20μ; l. 315μ. Plate II, Fig. 1.	N. S. Halifax, pond
**Pl. subcoronulatum* (Turner) W. and G. S. West (68)	N. S. Halifax, lake
**Pl. trabecula* (Ehrenb.) Naeg. (29) (including fa. *clavata*)	N. S. Kings, pond
	N. S. Lunenburg, bog
Pl. trabecula var. *maximum* (Reinsch) Roll (syn. *Docidium archeri* (Delp.) Wolle).	N. B. Northumberland (1)
Pl. trabecula var. *rectum* (Delp.) W. and G. S. West (syn. *Docidium rectum* (Delp.) Wolle).	N. B. Northumberland (1)
Pl. truncatum (Bréb.) Naeg. (syn. *Docidium truncatum* Bréb.)	N. B. Northumberland (3)
**Sphaerozosma excavatum* Ralfs (25)	N. S. Lunenburg, lake
	N. S. Queens, artificial lake
**S. excavatum* var. *subquadratum* W. and G. S. West (25)	N. S. Halifax, pond
**S. granulatum* Roy and Bissett (25)	N. S. Halifax (5)
	N. S. Lunenburg, stream
**Spondylosium planum* (Wolle) W. and G. S. West (25)	N. B. Charlotte, lakes
	N. S. Yarmouth, lake (51)
Sp. pulchrum Arch.	N. S. Yarmouth, lake (51)
Staurastrum aculeatum Ehrenb.	N. B. Northumberland (1)
**St. anatinum* Cooke and Wills (25)	N. B. Charlotte, lake
St. anatinum var. *longibrachiatum* W. and G. S. West	N. S. Yarmouth, lake (51)
**St. anatinum* var. *truncatum* W. West fa. (25) The specimens examined were biradiate.	N. S. Lunenburg, stream

**St. ankyroides* Wolle	N. S. Yarmouth, lakes (51)
**St. ankyroides* var. *pentacladum* G. M. Smith (48)	N. S. Yarmouth, lake
**St. arctiscon* (Ehrenb.) Lund. (48)	N. B. Charlotte, lake N. S. Yarmouth, lake (51)
**St. avicula* Brèb. var. *subarcuatum* (Wolle) W. West (25)	N. S. Kings, pond
**St. brachiatum* Ralfs (25)	N. S. Halifax, lake
**St. brebissonii* Archer var. *brevispinum* W. West (25) Our specimens agree very well with Irênée-Marie's description of this uncertain variety.	N. S. Halifax, bog
**St. brevispinum* Brèb. (25)	N. S. Yarmouth, lakes (51)
**St. brevispinum* fa. *major* W. West (25) Although West and Irénée-Marie state that the cell wall is smooth, the walls of some of our specimens are very finely, but distinctly punctate.	N. S. Lunenburg, lake N. S. Yarmouth, lake
St. brevispinum var. *tumidum* G. M. Smith	N. S. Yarmouth, lake (51)
**St. cerastes* Lund. (25)	N. S. Halifax, pond N. S. Lunenburg, stream N. S. Yarmouth, lakes (51)
St. cornutum Archer	N. B. Northumberland (1)
**St. crenulatum* (Naeg.) Delp. (25)	N. S. Halifax, pond
**St. cuspidatum* Brèb. (25)	N. S. Yarmouth, lake
**St. cyrtocerum* Brèb. (25)	N. S. Queens, pond
**St. dejectum* Brèb. (25)	N. S. Halifax, pond N. S. Queens, pond
St. echinatum Brèb.	N. B. Northumberland (1)
**St. furcigerum* Brêb. (25)	N. S. Halifax (5) N. S. Halifax, stream N. S. Kings, lake
**St. furcigerum* var. *armigerum* (Brêb.) Nordst. (25)	N. S. Kings, pond
St. grande Bulnh.	N. S. Yarmouth, lake (51)
St. hirsutum (Ehrenb.) Brêb.	N. B. Northumberland (1)
**St. jaculiferum* West (70) w. (with spines) 54μ; w. (without spines) 13μ; isth. 6.4μ; l. (without spines) 16μ. Plate III, Fig. 7.	N. S. Yarmouth, lake

**St. johnsonii* W. and G. S. West (21) w. 16-19μ; w. (incl. arms) 83-102μ; isth. 9-10μ; l. 38-45μ. Plate III, Fig. 5.	N. B. Charlotte, lake N. S. Lunenburg, lake N. S. Yarmouth, lake
St. leptacanthum Nordst.	N. S. Yarmouth, lake (51)
St. leptocladum Nordst.	N. S. Yarmouth, lake (51)
St. lunatum Ralfs	N. S. Pictou (26)
**St. margaritaceum* (Ehrenb.) Menegh. (25)	N. S. Pictou, pond
St. megacanthum Lund.	N. S. Yarmouth, lake (51)
St. muticum Brêb. var. *minus* (syn. fa. *minor* Rabenh. ?)	N. B. Northumberland (1, 3)
St. orbiculare (Ehrenb.) Menegh.	N. S. Halifax (5)
St. orbiculare (Ehrenb.) Ralfs fa. *minus* Nordst.	N. S. Pictou (26)
**St. ophiura* Lund.	N. S. Yarmouth, lakes (51)
**St. paradoxum* Meyen (48)	N. S. Queens, bog
**St. pentacerum* (Wolle) G. M. Smith (48)	N. S. Digby, lake
**St. pilosum* Arch. (25)	N. S. Halifax, bog
St. polymorphum Brêb.	N. S. Pictou (26)
St. polytrichum (Perty) Rabenh. (syn. *St. pringsheimii* Reinsch var. *duplo-major* Turner).	N. S. Pictou (63)
St. polytrichum fa. *majus*	N. S. Pictou (26)
**St. pseudopisciforme* Eich. and Gutw. (25)	N. S. Queens, pond
**St. pseudopelagicum* W. and G. S. West (48)	N. B. Charlotte, lake
**St. punctulatum* Brêb. (25)	N. B. Northumberland (1) N. S. Halifax, ponds N. S. Queens, pond N. S. Yarmouth, lake (51)
**St. pyramidatum* W. West? (25, 70) w. 51μ; isth. 15μ; l. 58μ. The spines on our specimens are not as coarse as indicated in the descriptions cited.	N. S. Queens, brook
**St. ravenellii* Wood var. *spinulosum* Irénée Marie (25) w. 21-38μ; isth. 7-14μ; l. 25-35μ.	N. S. Halifax, bog N. S. Lunenburg, stream
**St. rotula* Nordst. (48)	N. B. Charlotte, lake
**St. setigerum* Cleve (48)	

**St. spongiosum* Bréb. (25)	N. S. Pictou (63) N. S. Queens, pond
**St. subcruciatum* Cooke and Wills (56)	N. S. Halifax, bog
**St. subgracillimum* W. and G. S. West (70)	N. S. Yarmouth, lake
**St. suborbiculare* W. and G. S. West (38) w. 29-32μ; isth. 9-10μ; l. 35μ. In vertical view the sides are slightly more concave, and in lateral view the angles more rounded than in Prescott's figure.	N. S. Halifax, pond N. S. Queens, pond
**St. tohopekaligense* Wolle var. *nonanum* Turner (25) w. 23-26μ; isth. 14-16μ; l. 29-32μ. Plate III, Fig. 8. Dimensions smaller than reported by Turner or Irénée-Marie. The ends of the processes bear from two to five short spines.	N. S. Halifax, pond N. S. Hants, pond
St. wolleanum Butler	N. S. Yarmouth, lake (51)
**Staurastrum sp.* w. (with processes) 86μ; w. (without processes) 48μ; isth. 19μ; l. (with processes) 96μ; l. (without processes) 70μ. Plate III, Fig. 6. Each semi-cell has two whorl of processes, one whorl of six at the equator and another whorl of six near the apex. The author has been unable to identify this species which is comparable in some respects with *St. nudibrachiatum* Borge.	N. B. Charlotte, Potter's Lake
**Tetmemorus brebissonii* (Menegh.) Ralfs (25)	N. B. Northumberland (3) N. S. Halifax, bog, ponds, lake N. S. Lunenburg, bog N. S. Queens, bog N. S. Pictou, lake

**T. brebissonii* var. *minor* de Bary (25)	N. S. Halifax, pond, lake N. S. Queens, bog
**T. granulatus* (Brêb.) Ralfs (25)	N. S. Halifax, pond
**T. granulatus* var. *attenuatus* W. West (56)	N. S. Queens, bog
**Triploceras gracile* Bailey (29)	N. S. Halifax, bog, lake N. S. Lunenburg, lake N. S. Yarmouth, lake (51)
**Tr. gracile* var. *bidentatum* Nordst.	N. S. Hants, lake N. S. Queens, river N. S. Lunenburg, lake
Tr. verticillatum Bailey	N. S. Yarmouth, lake (51)
**Xanthidium antilopaeum* (Brêb) Kuetz.	N. B. Northumberland (3) N. S. Halifax, ponds (5) N. S. Yarmouth, lake (51)
X. *antilopaeum* var. *canadense* Joshua	N. S. Pictou (26)
**X. antilopaeum* var. *hebridarum* W. and G. S. West (25)	N. S. Digby, lake
**X. antilopaeum* var. *polymazum* Nordst. (25)	N. S. Halifax, ponds N. S. Hants, brook N. S. Kings, lake N. S. Queens, river N. S. Pictou, lake N. S. Yarmouth, lakes (51)
**X. antilopaeum* var. *minneapolense* Wolle (25)	N. S. Halifax, bog
**X. armatum* (Brêb.) Rabenh. (25)	N. S. Halifax, stream N. S. Lunenburg, bog N. S. Pictou, lake
**X. armatum* var. *fissum* Nordst. (25)	N. S. Halifax, pond N. S. Lunenburg, stream
**X. armatum* var. *mediolaeve* G. M. Smith (48) w. (with processes) 93μ; w. (without processes) 73.6μ; isth. 29μ; l. (with processes) 118μ; l. (without processes) 102μ. Plate II, Fig. 13.	N. S. Halifax, pond, lake N. S. Yarmouth, lake (51)
X. *columbianum* Wolle	N. B. Northumberland (1)

*X. *cristatum* Brēb. (25)	N. B. Northumberland (3) N. S. Halifax, pond N. S. Hants, pond, lake N. S. Pictou, lake
*X. *cristatum* var. *hipparquii* Irénée-Marie (25)	N. S. Pictou, lake
*X. *cristatum* var. *uncinatum* (Breb.) (25)	N. S. Halifax, bog, pond N. S. Hants, lake N. S. Yarmouth, lake (51)
X. *fasciculatum* Ehrenb. var. *hexagonum* Wolle	N. B. Northumberland (1)
X. *fasciculatum* Ehrenb. var. *subalpinum*	N. B. Northumberland (1)
X. *subhastiferum* W. West var. *murrayi* W. and G. S. West fa. *triquetra* W. and G. S. West	N. S. Yarmouth, lake (51)
*X. *sp.* Plate II, Fig. 14 w. 55μ.; 58μ; w. isth. 14μ. In some respects this species resembles X. *antilopaeum* var. *polymazum*. There are, however, no terminal spines and the lateral spines are much shorter. Near the apical margin of each semicell is an arc of six large granules. Between the two lowest granules of the arc is a centrally disposed pair of large granules.	N. S. Queens, river,
Mesotaeniaceae	
**Cylindrocystis americana* W. and G. S. West var. *minor* Cushman (25)	N. S. Halifax, bog
**C. brebissonii* Menegh. (25) (syn. *Penium brebissonii* (Menegh.) Ralfs).	N. B. Northumberland (1) N. S. Queens, brook
C. crassa de Bary (syn. *Penium crassum* (de Bary) Wolle).	N. B. Northumberland (1)
**Gonatozygon kinahani* (Arch.) Rabenh. (25)	N. S. Halifax, lake N. S. Lunenburg, bog
**G. aculeatum* Hastings (25)	N. S. Kings, lake N. S. Queens, river

Mesotaenium macrococcum (Kuetz.) Roy and Biss. (syn. *M. braunii* de Bary).	N. B. Northumberland (1)
* *Netrium digitus* (Ehrenb.) Itzig and Rothe	N. B. Charlotte, lake N. S. Halifax, stream, bog, lake N. S. Yarmouth, lake (51)
N. digitus var. *lamellosum* (Brèb.) Groenblad (syn. *Penium lamellosum* (Brèb.) Kuetz.	N. B. Northumberland (1) N. S. Halifax (5)
* *N. interruptum* (Brêb.) Luetke. (syn. *Penium interruptum* Brèb.)	N. B. Northumberland (1) N. S. Halifax, pond
* *N. interruptum* var. *minor* (Borge) Krieger (29) w. 20μ; l. 70μ. Cells shorter than previously reported for the variety.	N. S. Cumberland, ditch
* *N. naegelii* (Brêb.) W. and G. S. West (25)	N. S. Cumberland, ditch
* *N. oblongum* (de Bary) Luetke. (29) (syn. *Penium oblongum* de Bary).	N. B. Northumberland (1) N. S. Halifax, lakes
**Spirotaenia condensata* Breb. (29)	N. B. Northumberland (1) N. S. Halifax, swampy ditch N. S. Queens bog, lake
Sp. obscura Ralfs.	N. B. Northumberland (1)

ACKNOWLEDGMENTS

The writer wishes to express his thanks to Dr. E. N. Transeau and Dr. C. E. Taft for encouragement and helpful criticism, and to Dr. M. W. Smith, Dr. W. G. Dore, Dr. A. E. Roland, and Dr. J. A. C. Nicol for providing useful additional collections.

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PLATE I

1. *Closterium dianae* Ehrenb. var. *brevius* (Wittr.) Petkoff (x395).
2. *Cl. angustatum* Kuetz. var. *annulatum* var. nov. (x420).
3. *Cl. subjuncidiforme* Groenblad (x255).
4. *Cl. acerosum* (Schrank) Ehrenb. var. *angustius* var. nov. (x285).
5. *Cl. ehrenbergii* Menegh. var. *malinvernianum* (De Not.) Rabenh. (x250).
6. *Cl. abruptum* W. West (x255).
7. *Cl. toxon* W. West (x265).
8. *Cosmarium orthostichum* Lund. (semi-cell x550).
9. *Micrasterias conferta* Lund. fa. (x255).
10. *M. mahabuleshwarense* Hobson var. *ringens* (Bail.) Krieger (semi-cell x245).
11. *M. ra i ta* Hass. var. *gracillima* G. M. Smith (semi-cell x266)
12. *M. thomasiana* Arch. (x235).

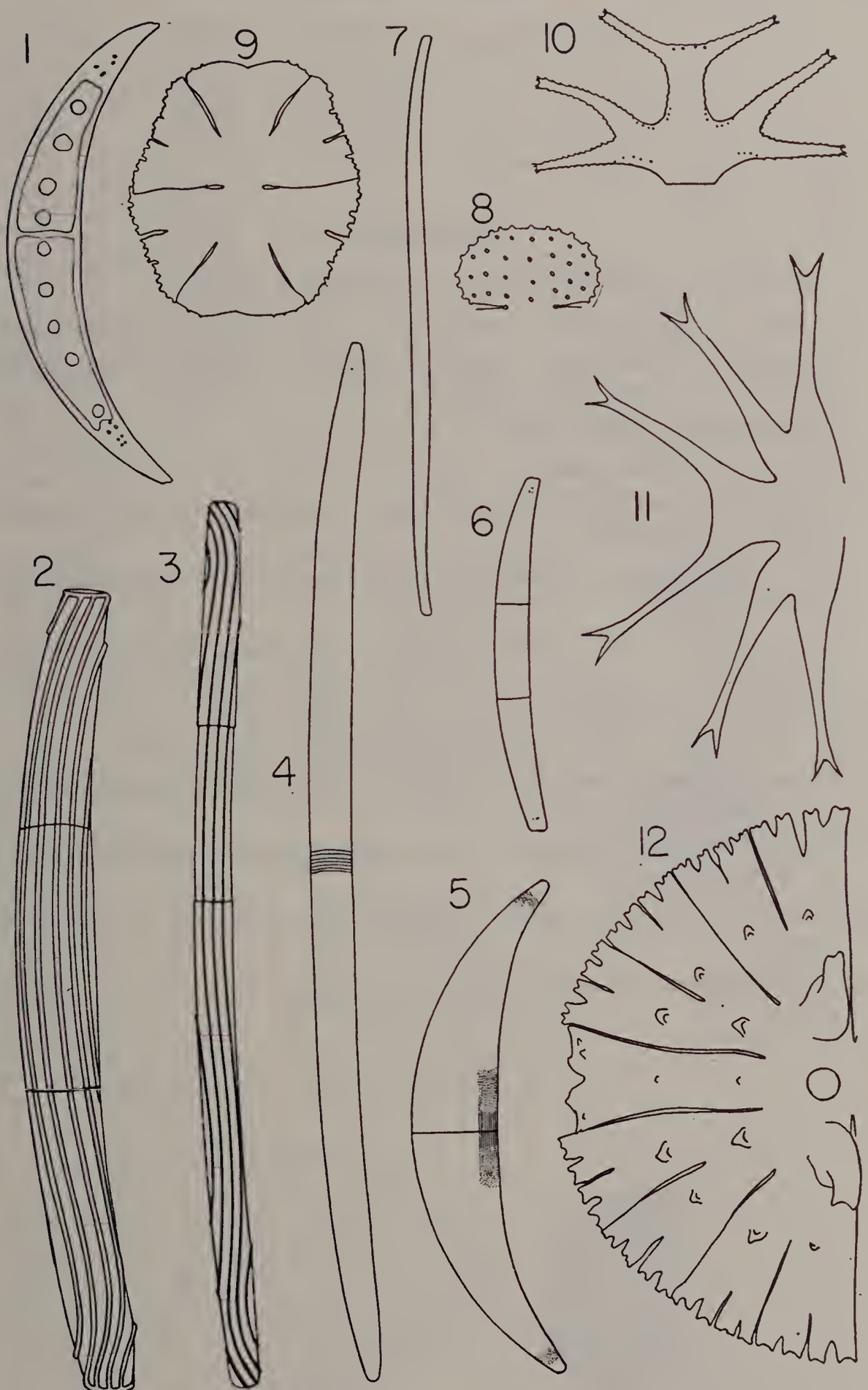

PLATE I

PLATE II

1. *Pleurotaenium nodosum* Bailey (semi-cell x 265).
2. *Penium spirostriolatum* Barker var. *amplificatum* Schmidt (x260).
3. *Euastrum denticulatum* (Kirch.) Gay var. *angusticeps* Groenblad (face and apical view x710).
4. *Eu. ciastonii* Racib. (x770).
5. *Eu. didelta* Ralfs (x285).
6. *Cosmarium taxichondrum* Lund. var. *subundatum* Boldt (face and apical view x430).
7. *C. taxichondrum* var. *unigranulatum* Prescott (face and apical view x475).
8. *C. quinarium* Lund. var. *hexagonum* var. nov. (face and lateral view x420).
9. *C. isthmium* fa. *hibernicum* W. West (x425).
10. *C. eloisianum* Wolle var. *scrobiculatum* var. nov. (x415).
11. *C. panamense* Prescott var. *smithii* var. nov. (lateral, face, and apical view of semi-cell x565).
12. *C. ovale* Ralfs var. *prescottii* Irênée-Marie (lateral and surface view of semi-cell x275).
13. *Xanthidium armatum* (Breb.) Rabenh. var. *mediolaeve* G. M. Smith (x265).
14. *Xanthidium sp.* (face and lateral view x250).

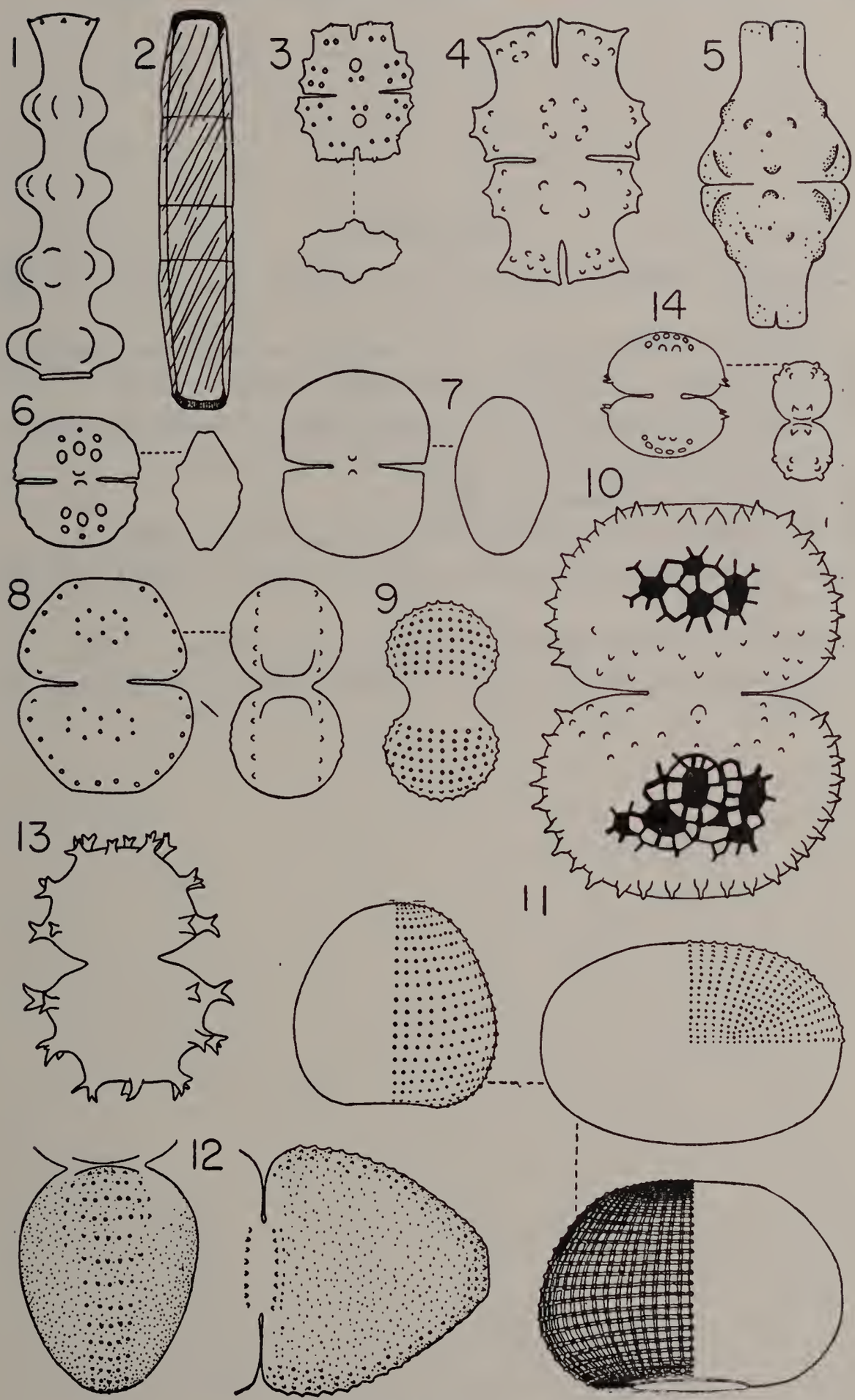

PLATE II

PLATE III

1. *Euastrum sinuosum* Lenorm. var. *reductum* W. and G. S. West (x900).
2. *Eu. crassum* (Breb.) Kuetz. var. *scrobiculatum* Lund. (semi-cell x270)
3. *Eu. sinuosum* var. *germanicum* (Raçib.) Luetke. (x615).
4. *Cosmarium sulcatum* Nordst. (lateral, face, and apical view x630).
5. *Staurastrum johnsonii* W. and G. S. West (x275).
6. *Staurastrum sp.* (semi-cell x580).
7. *St. jaculiferum* W. West (lateral and apical view x520).
8. *St. tohopekaligense* Wolle var. *nonanum* Turner (lateral and apica view x615).
9. *Coelastrum chodati* Duc. (one-quarter of coenobium x1000).
10. *Peridinium limbatum* (Stokes) Lemm. (ventral and dorsal view x600).

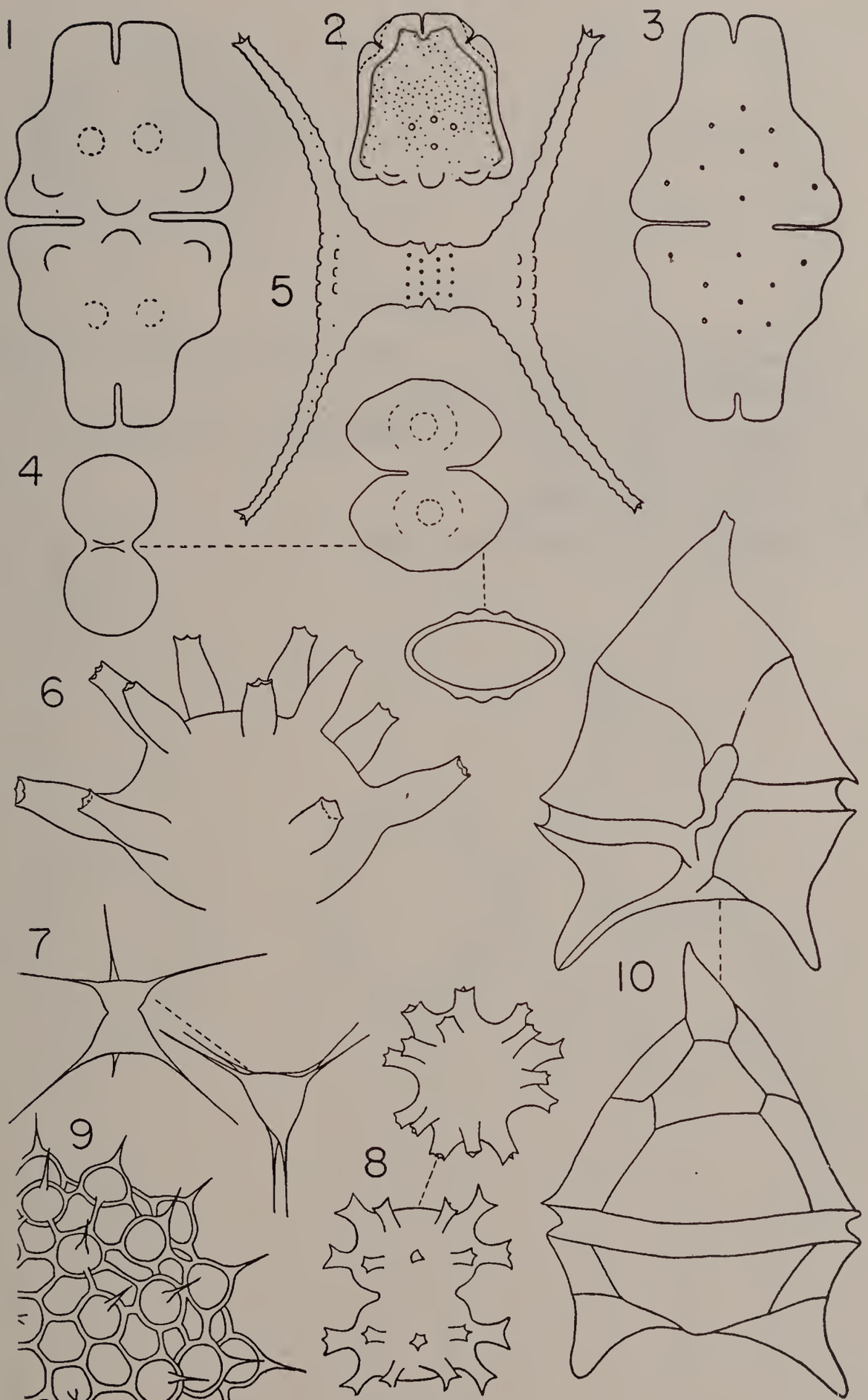

PLATE III

PLATE IV

1. *Bulbochaete woronichini* Tiffany (median view of one-half of oospore surface view of the remainder x750).
2. *Oedogonium zehneri* Tiffany var. *pyriforme* var. nov. (x630).
3. *Oe. gallicum* Hirn (x500).
4. *Oe. armigerum* Hirn (x835).
5. *Oe. borisianum* (leClerc) Wittr. (x390).

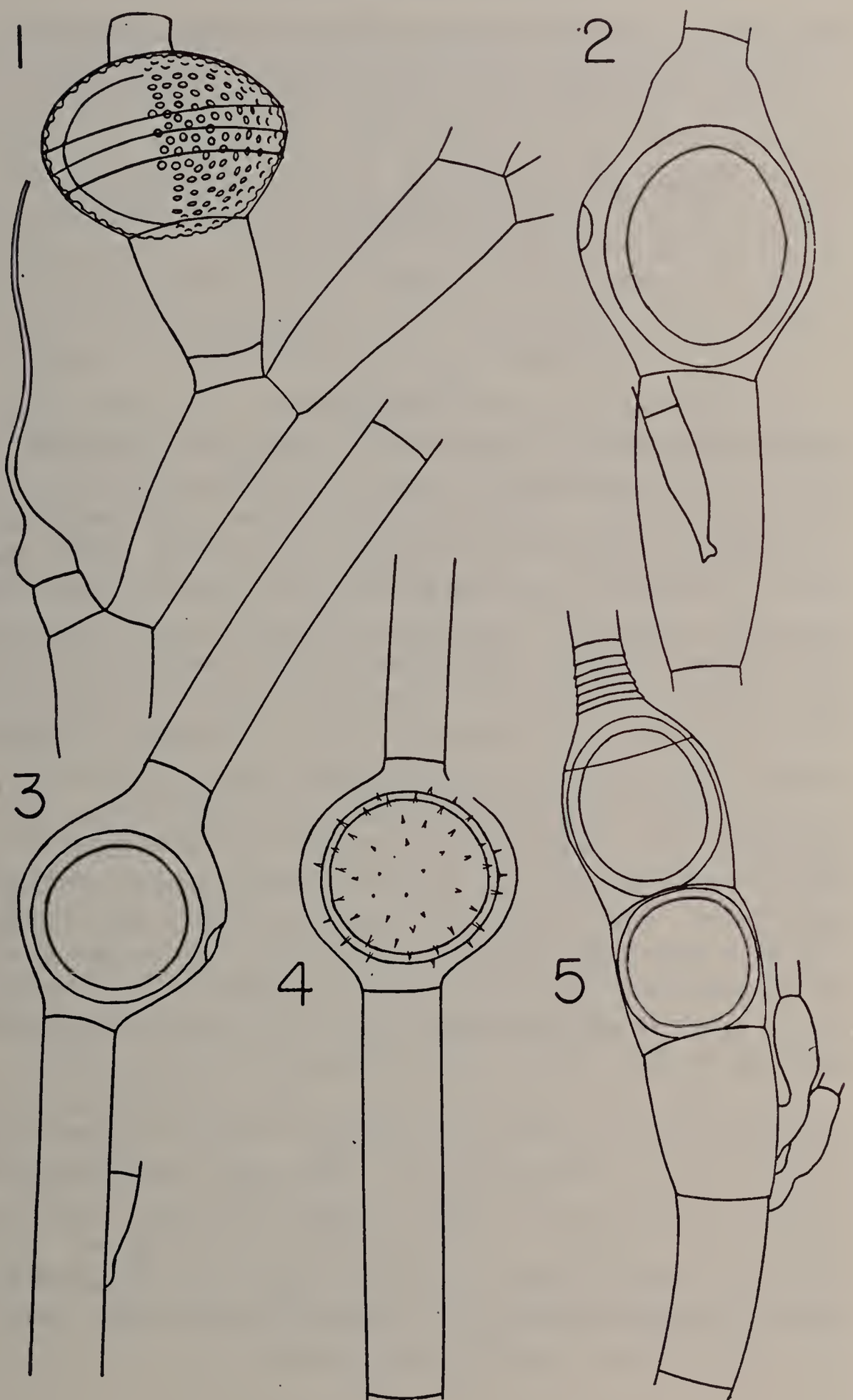

PLATE IV

Tetrastichus Minutus (Howard) (Hymenoptera: Eulophidae) Reared from the Lady-Beetle, *Adalia Bipunctata* L.

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(Received for publication Oct. 13, 1948)

MATERIALS AND METHODS

On November 15, 1946, ninety pupae of the lady-beetle, *Adalia bipunctata* L. were removed from the lower trunks of a row of birches on the campus of McMaster University, Hamilton, Ontario. When the pupae were examined in the laboratory two small wasps were found moving about over them. These were captured and pinned. Each of 84 of the pupae was placed in a numbered vial (40 mm. x 10 mm.) and the vial was plugged with cotton, and the series of vials was kept at room temperature. Six of the pupae were dissected beneath a binocular microscope. Three pupae were found to contain 7 small larvae, two contained 10 and 12 larvae respectively and one contained 1 live larva and three empty pupal skins and had a small emergence hole in the thorax. The larvae wriggled sluggishly when removed from the coccinellid pupal skin. They were 2.0-2.5 mm. in length, had smooth skin and were light brown in colour. The body tapered to a blunt point anteriorly and posteriorly and showed a head and a series of thirteen segments, in this respect resembling the larva of *T. brevistigma* Gahan figured by Berry (1938).

On November 23, the pupae in vials were examined for holes made by the emerging parasites. Twenty pupae were found to have emergence holes. The pupae were left until August 6, 1948, and as adult parasites emerged they were pinned and numbered and their dates of emergence were recorded. On August 6, 1948, all pupae were dissected beneath a binocular microscope and all remaining larvae, pupae and adults were removed and preserved.

During the course of the observations one hundred and two adult parasites emerged from the pupae. These were examined by Dr. O. Peck, Division of Entomology, Department of Agriculture, Ottawa, who kindly determined the sex of the specimens. Mr. A. B. Gahan of the United States National Museum kindly identified the adults as dark northern specimens of *Tetrastichus minutus* (Howard) a species previously recorded by Burks (1943) as reared from the lady-beetle *Cycloneda sanguinea* (L.) and from several aphids and scales.

RESULTS

Fifty-four of the ninety coccinellid pupae collected proved to be parasitized. Six of these were dissected and were found to contain larvae, as noted previously, ten showed emergence holes made previously to November 23, 1946, and thirty-eight produced parasites after November 23, 1946. Of the thirty-six non-parasitized pupae four produced adults of *Adalia bipunctata* (Nov. 16—2, Nov. 17—1, Nov. 20—1, 1947) and thirty-two were found to be empty and had no emergence holes.

LOCATION OF EMERGENCE HOLES

Holes made in the walls of the coccinellid pupae by emerging adult parasites were measured with a stage micrometer under a binocular microscope and were found to be circular with diameter 0.3-0.4 mm. In most of the pupae a single emergence hole appeared but in some there were two holes. The location of these holes is summarized as follows:

head—center, upper right corner, upper left corner, top of head.

prothorax—mid-line of pronotum, left side of pronotum.

mesothorax—left corner of mesonotum.

metathorax—right side of metanotum, left side of metanotum.

abdomen—mid-line of terga of segments one and five, right and left corners of tergum of segment two,

mid-line of sternum of segments two and three, mid-line of venter of abdomen at suture between segments two and three and between segments three and four, left and right corners of segment two, end of abdomen.

EMERGENCE OF ADULT PARASITES

A total of one hundred and two adults emerged from the pupae between Nov. 15, 1946 and June 23, 1947, the peak of emergence being on April 18, 1947. Both males and females emerged from eleven pupae, males alone emerged from seven pupae and females alone emerged from twenty-five pupae.

PERCENTAGE PARASITISM

Of the fifty-four parasitized pupae forty-four produced no parasites previous to Nov. 23, 1946, while ten had produced parasites previous to Nov. 23, 1946. Of the non-parasitized pupae four produced adults of *Adalia bipunctata* and thirty-two were empty. The percentage parasitism was then (54: 90) x 100 =60%.

The number of parasites per pupa varied from one to twelve. In the six pupae dissected on November 15, 1946, all the parasites were living larvae and pupae from seven to twelve in number. The peak of emergence of adults (2 males and 9 females) occurred on April 18, 1947. It is thus evident that the parasites, under normal conditions, would have overwintered in the coccinellid pupae, an observation similar to that made by Berry (1938) in his study of *T. brevistigma* parasitizing the elm leaf beetle. The distribution of the number of pupae, with respect to the number of parasites produced, (including only those from which no adults emerged before November 23, 1946), is shown in Table I.

Distribution of Pupae With Respect to Number of Parasites Produced

Number of parasites	1	2	3	4	5	6	7	8	9	10	11	12
Number of Pupae	8	6	8	3	7	2	6	0	0	2	0	1

SEX RATIOS

A total of one hundred and two adults emerged from the pupae between Nov. 15, 1946 and June 23, 1947. In addition sixteen dead adults were dissected from the pupae on August 4, 1948. Of the total number of adults (118) 32 were males and 86 females, giving a percentage of 27.1% males and 72.9% females. Twenty-eight pupae produced no adults before Nov. 23, 1948, and when dissected on August 4, 1948, were found to contain no larvae or pupae. They may therefore be used in estimating the ratio of sexes of adult wasps from individual pupae. These pupae produced 23 males and 80 females, giving a ratio of 28.8% males to 71.2% females approximating that of the sexes in the total population.

DISPOSITION OF SPECIMENS

Of the one hundred and two adults which emerged from the pupae between Nov. 15, 1946, and June 23, 1947, three males and six females are retained in collections at McMaster University, while the remaining ninety-three are deposited in the Canadian National collection at Ottawa.

LITERATURE CITED

Berry, P. A. 1938. Tetrastichus brevistigma Gahan, a pupal parasite of the elm leaf beetle. U.S.D.A. Circular 485.

Burks, B. D. 1943. The North American parasitic wasps of the genus Tetrastichus—a contribution to biological control of insect pests. Proc. U. S. Nat. Museum, no. 3170. (93:505-608).

PRESIDENTIAL ADDRESS

C. C. Coffin

(Read October 20, 1947)

Members of the Institute:

It is gratifying to be able to make this brief report of the Institute's activities for the past year without having to refer to the death of any member.

During the year 9 ordinary and 18 student members were elected. In addition the Council saw fit to confer Honorary Membership on certain of our number who have rendered long and distinguished service to Science and the Institute. These are H. E. Bigelow, H. L. Bronson, John Cameron, P. R. Colpitt, L. C. Harlow, A. G. Huntsman, S. G. Ritchie and F. H. Sexton.

Our membership as of September 11 thus stands as follows:

Ordinary members	56
Associate	44
Student	49
Honorary	13
Life	10
Total	172

Six ordinary meetings with an average attendance of 41 were held and 15 papers and 1 demonstration were presented. These may be classified as follows:

Biochemistry	1	
Biology	4	
Chemistry	2	
Fisheries	2	
Physics	4	(plus 1 demonstration)
Physiology	2	

In addition an extraordinary meeting was held on March 17 at which a very interesting paper on "Plant Viruses" was

presented by Dr. D. J. McLeod, Officer-in-Charge, Division of Botany and Plant Pathology, Fredericton, N. B.

During the year Volume XXI, Parts 3 and 4 of our Proceedings was published. This is noteworthy in being the largest single issue ever published by the Institute and consists entirely of a paper entitled "The Flora of Nova Scotia," by Dr. A. E. Roland, Provincial Botanist. Both the author and the editor are to be congratulated on this issue.

The Reports of the other officers will be found elsewhere in this issue.

In conclusion I would like to thank the members of Council or their assistance and support throughout the year.

PROCEEDINGS OF MEETINGS.

Session of 1947-48

(All meetings were held in the Medical Sciences Building, Dalhousie University, Halifax)

86*th Annual Business Meeting*, October 20, 1947.

The President, Dr. C. C. Coffin, presided with 21 members attending. His annual address is printed in full in the Proceedings. Reports of officers were presented and are summarized as follows:

Treasurer's Report:

Receipts	$3,659.37
Expenditures	3,659.55
Total assets, current account	645.70
Total assets, permanent fund	3,500.00

The Corresponding Secretary reported that efforts were made to extend the exchange list by offering exchanges to 192 Societies from whom nothing had been received in recent years. This resulted in 80 resumptions in the exchange list. A total of 59 new additions to the exchange list was made. In addition 448 back numbers have been sent out.

The Editor reported that parts 3 and 4 of Volume XXI of the Proceedings were published in April, 1947. This was the largest issue ever published by the Institute bringing Vol. XXI to a total of 663 pages as compared with an average of almost 300 pages for the previous 7 volumes. Part 1 of Volume XXII will go to press shortly.

The Librarian reported that 1823 publications had been received through the exchange list, a considerable increase over the previous year, and that 1426 books and pamphlets had been borrowed from the library.

Officers elected for the year 1947-48 were:

President	Dr. C. C. Coffin
1st Vice-President	Dr. C. B. Weld
2nd Vice-President	Dr. A. E. Cameron

Treasurer.....D. K. Crowdis, Esq.
Corresponding Secretary.....Dr. W. J. Chute
Recording Secretary.....Dr. W. J. Dyer
Council.....R. E. S. Homans, Esq., Dr. W. J. Archibald, Dr. J. Aldous, Dr. H. D. Smith, and Dr. D. Pelluet.
Editor.....Dr. E. Hess
Librarian.....D. K. Crowdis, Esq.
Auditors.....Dr. R. J. Bean and Dr. H. L. Bronson

Nominations to the Provincial Science Library Commission: Dr. J. H. L. Johnstone and Dr. E. G. Young.

The election of Mr. W. M. Creelman as ordinary member by Council on May 5 was announced.

In addition, notice was received from the Secretary of the Provincial Library Commission of projected changes in the administration and possibly housing of the Provincial Science Library, of which the Institute Library forms a part.

1*st Ordinary Meeting*, November 10, 1947.

The following new members were announced (elected by Council, November 10); F. L. M. Pattison, Ph.D., Melville Shachter, M.D.,C.M., E. W. Guptil, Ph.D., ordinary members; Peter Yates, B.Sc., S. G. Whiteway, B.Sc., L. B. MacIsaac, B.Sc., F. A. Brothers, B.Sc., G. A. Dauphinee, B.Sc., A. Gordon, B.Sc., D. H. Campbell, Miss Marjorie Smith, B.Sc., Miss Louise Jodrey, B.Sc., Alex Stewart, B.Sc., D.W. Wylie, B.Sc., C. L. Pigott, E. S. Warren, G. J. B. Crawford, R. A. Cameron, student members.

Papers: "The Magnetic Moment of the Nucleus," by W. J. Archibald; "The Proteins of Egg Yolk of the Atlantic Salmon," by E. G. Young and J. I. Phinney.

Demonstration: "The Tiselius Electrophoresis Apparatus," by E. G. Young and J. I. Phinney.

2nd Ordinary Meeting, December 8, 1947.

The following new members were announced (elected by Council, December 8); George Cox, Ph.D., associate member; Sr. M. Rosaria, K. N. Barnard, M.Sc., O. A. Sandoz, M.Sc., ordinary members; Daniel Livingstone, B.Sc., student member.

Papers: "Oil Globules in Lung Tissue," by C. B. Weld; "The Determination of Ionic Transference Numbers and Complex Ion Concentrations with Radioactive Isotopes," by C. C. Coffin.

Demonstration: "The Measurement of Artificial Radioactivity," by C. C. Coffin and S. G. Whiteway.

3rd Ordinary Meeting, January 12, 1948.

The following new members were announced (elected by Council, January 12); Irwin M. Murray, M.D.,C.M., J. W. Abbiss, M.B.,Ch.B.,M.R.C.S.,L.R.C.P., F. A. Vandenheuvel, Ph.D., H. E. Power, B.E., ordinary members; Ian H. S. Henderson, student member.

Papers: "An Investigation of Pharmacologically-active Fluorine Compounds," by F. L. M. Pattison; "The Influence of Monoiodoacetic Acid Upon the Viability of Yeast Cells," by J. G. Aldous.

4th Ordinary Meeting, February 9, 1948.

Papers: "The Iodine Content of Foods," by Roberta B. Campbell and E. G. Young; "Ship Corrosion in Sea Water as Detected by Potential Surveys," by K. N. Barnard.

5th Ordinary Meeting, April 12, 1948.

It was announced that Mr. R. W. Tufts of Wolfville was elected an Honorary Member of the Institute by Council on April 12.

Papers: "The Effect of Adding Basic Slag and Ammonium Nitrate to Lakes," by F. R. Hayes and Coworkers; "The

Fluorophosphonates: A New Type of War Gas," by F. L. M. Pattison.

6*th Ordinary Meeting*, May 3, 1948.

Papers: "Reactions of Aromatic Dinitriles," by Peter Yates; "Qualitative Detection of Nitrate Esters," by N. Milford; "The Oxygen Consumption of Developing Eggs of Salmo Salar," by Isabella Wilmot.

The Magnetic moment of the nucleus. W. J. Archibald, Physics Dept., Dalhousie University, Halifax, N. S. (Read November 10, 1947:. A magnet, when placed in a uniform magnetic field, possesses energy. However, according to the principles of the quantum mechanics, only certain discrete energy states are possible and transitions between these states are accompanied by the emission or absorption of radiation. A nucleus, which acts like a magnet of moment μ, when placed in a strong magnetic field, can exist in one of several energy states. When it passes from a high energy state E_2 to a lower one E_1, a quantum of energy hv is emitted, where

$$h\nu = E_2 - E_1 = \frac{H\mu}{J}$$

(H is the magnetic field strength, μ the magnetic moment of the nucleus and J the angular momentum quantum number). Thus the measurement of v and H enables μ to be determined.

$$\frac{}{J}$$

The Proteins of Egg Yolk of the Atlantic Salmon. E. G. Young and J. I. Phinney, Dept of Biochemistry, Dalhousie University, Halifax, N. S. (Read November 10, 1947). The proteins in the yolk of the unfertilized eggs of the Atlantic salmon (*Salmo salar*) have been fractionated by several methods. The yolks were diluted with 10% sodium chloride or 2% ammonium sulfate and exhaustively extracted with diethyl ether. A lipoprotein was precipitated from the resulting aqueous solution at pH 3.7. It contained about 3% of lipid which was extractable by treatment with ethanol at 7% concentration. It appeared to be readily denatured and could be redissolved only partially in dilute ammonia at pH 8. On analysis it exhibited a concentration of nitrogen of 15.73 % and of phosphorus of 1.32 % on a moisture and ash-free basis. Only a trace of protein remained unprecipitated.

The lipoprotein was also isolated by the Piettre technique with acetone at a concentration of 70%.

The proteins of the yolk have also been analyzed in the Tiselius electrophoresis apparatus in which three migrating boundaries were visible. They were distributed in the proportion of 87,9.2 and 3.8%.

Oil Globules in lung Tissue. C. B. Weld, Dept. of Physiology, Dalhousie University, Halifax, N. S. (Read December 8, 1947.) Oil globules are demonstrable in the alveolar walls in cats, dogs, guinea pigs and monkeys. These globules are more numerous in animals absorbing a fatty meal and in some cases the picture suggests oil embolism. The appearance is not due to a histological artefact nor is it due to aspiration of oil. Lung fat determinations show higher values when excessive oil deposits are present. The oil globules appear in lung during fat absorption whether or not there is an alimentary lipemia; the liver is suggested as the source of the globules.

The Determination of Ionic Transference Numbers and Complex Ion Concentrations with Radioactive Isotopes. C. C. Coffin, Dept. of Chemistry, Dalhousie University, Halifax, N. S. (Read December 8, 1947). Radioactive silver (half-life 225 days) and antimony (half-life 60 days) have been used to follow the movement of the respective elements during electrolysis. The results with silver agree with Hit-

torf's classic experiments and confirm the existence of the $Ag(CN)_2$— ion. In the case of antimony the existence of a very stable negative complex was established and its dissociation constant was determined.

An Investigation of Pharmacologically-Active Fluorine Compounds. F. L. M. Pattison, Dept. of Chemistry, Dalhousie University, Halifax, N. S. (Read January 12, 1948). This work, carried out under the aegis of the Ministry of Supply in the University of Cambridge, was supervised by Dr. B. C. Saunders and was undertaken with a view to obtaining new chemical warfare agents. The preparation and chemistry of certain fluorine containing compounds are described. Pharmacological examination was carried out on rabbits, guin a pigs, rats and mice either by injection of solutions or inhalation of known concentrations of vapor; details of toxicities of some of the substances described are appended. All the toxic compounds produced characteristic convulsions and death at very low concentrations.

Several compounds derived from fluoroacetic acid are described all of which were highly toxic. Following on from this, a remarkable alternation of toxicity is described for members of the homologous series of general formula F (CH_2)n COOR. When n is odd the compound is extremely toxic and when n is even the compound is nontoxic; moreover, the toxicity of the compounds where n is odd increases with ascent of the series. Members investigated included esters of fluoroacetic acid, 5-fluorohexoic acid, 9-fluorodecoic acid, 10-fluoroundecoic acid and 11-fluoroduodecoic acid.

The results are discussed critically in the light of the B-oxidation theory of fatty acids in the animal body. Evidence for such a mechanism was afforded by the synthesis of several compounds structurally related either to methyl 3-fluorobutyrate or to ethyl 5-fluorohexoate but in which B-oxidation was inhibited, notably methyl 2-fluoromethyl-3:6-endomethylene-Δ4-tetrahydro-benzoate, methyl 2-fluoromethyl-4:5-dimethyl-Δ4-tetrahydrobenzoate and the reduced form of these two compounds, methyl 3-fluoro-2:2-dimethylbutyrate and p-fluorophenylacetic acid. These substances were without exception non-toxic.

The Influence of Monoiodoacetic Acid Upon The Viability of Yeast Cells. J. G. Aldous, Dept. of Pharmacology, Dalhousie University, Halifax, N. S. (Read January 12, 1948) The number of yeast cells remaining viable in a suspension which has been exposed to a given concentration of iodoacetic acid (10^{-3}M) varies with the pH of the medium in which the cells are suspended. Over the pH range 3.5 to 5.5 the effect of the poison is irreversible, its lethal action varying in magnitude from zero to 100 percent.

Calculations of the percentage dissociation of iodoacetic acid at several points in this pH range were made and the values obtained were plotted against percent viable cells. The straight line obtained strongly suggests that the lethal action of iodoacetic acid is directly proportional to the concentration of the undissociated molecules.

The Iodine Content of Foods. Roberta B. Campbell and E. G. Young, Dept. of Biochemistry, Dalhousie University, Halifax, N. S. (Read February 9, 1948) The content of iodine in Maritime fruits and vegetables has been determined by a modified Pfeiffer procedure, The sensitivity of the method was found to be about 50 parts per billion.

The results obtained were within the range of values previously reported and near the mean. No correlation of iodine content with variety was evident. A compilation of all the values for foods recorded in the literature has been made and tabulated.

Ship Corrosion in Sea-Water as Detected by Potential Surveys. K. N. Barnard, Naval Research Establishment, HMCS Stadacona, Halifax, N. S. (Read February 9, 1948). The technique used while carrying out a potential survey of a ship's hull was outlined, and typical results of a series of surveys were given. These surveys were made in conjunction with a drydocking program during which the state of the hull was deliberately altered so that the corrosion patterns could be followed under a variety of hull conditions.

The Effect of Adding Basic Slag and Ammonium Nitrate To Lakes. F. R. Hayes and Coworkers, Dept. of Biology, Dalhousie University, Halifax, N. S. (Read April 12, 1948). In the summer of 1947 six lakes in Halifax County were subjected to periodic examination. Two of the lakes were treated with basic slag(a source of phosphorus), and two others with basic slag and ammonium nitrate. Two more served as controls. The lakes averaged some 6 acres in area and 0.9 million cubic feet in summer volume. Considerable normal fluctuation was found in the control values for phosphorus and nitrogen. As would be expected, the addition of nitrogen caused an increase of dissolved nitrogen in the lake; the same is true of phosphorus. In one case clearly, and in another doubtfully, the basic slag promoted an increase in nitrogen, which would indicate either the presence of nitrogen fixers in the water, or the bringing up of organic nitrogen out of the bottom mud. The dry weight and relative species abundance of plankton was estimated, the latter giving no clear results in relation to treatment. Dry weights were not always clear, but in the most fertile lake (on chemical analysis), the plankton disappeared, indicating perhaps a marked alteration in the biological balance. In the same lake there was an alteration in vegetation during the summer. Measurements of leaf sizes of aquatic plants were also made, but could not be fitted into the experimental treatment in any systematic way.

The Fluorophosphonates, A New Type of War Gas. F. L. M. Pattison, Dept. of Chemistry, Dalhousie University, Halifax, N. S. (Read April 12, 1948). The work described in this paper reviews the results obtained by a research team working in Cambridge for the Ministry of Supply under the direction of Dr. H. McCombie and Dr. B. C. Saunders with a view to obtaining new chemical warfare agents. Pharmacological examination was carried out on rabbits, rats, guinea pigs and mice, either by injection of solutions or inhalation of known concentrations of vapor; details of some of the substances described are appended. All the toxic members produced death rapidly and at very low concentrations.

The toxicity of the compounds was due to the fact that they inhibited the enzyme cholinesterase at concentrations as low as 10^{-10}M, with resultant build-up of acetylcholine in the body. Sublethal doses, which were undetectable chemically or by sensory warning, resulted in typical parasympathomimetic symptoms such as pin-point pupils and bronchial constriction.

The toxic members all have the general formula $(RO)_2$ POF, where R is any alkyl radical, the most toxic of these being where R possesses a

secondary carbon atom directly attached to the oxygen. General methods of preparation are described and points of interest of some of the more important members are elaborated. Phosphorus oxy-dichlorofluoride afforded a means of preparing many novel compounds, including $(C_2H_5S)^2POF$, $(PhO)^2POF$, $(PhNH)_2POF$ and (PhNH-) (C_2H_5O-) POF, none of which showed any marked toxicity. Di-isopropyl fluorophosphonate was prepared on a semi-technical scale in Britain during the war.

Reactions of Aromatic Dinitriles. Peter Yates, Dept of Chemistry, Dalhousie University, Halifax, N. S. (Read May 3, 1948.) This work was done as an extension of work by Drew and Kelly on the preparation of a new group of compounds—the dithio-B-isoindigos—by the action of ammonia and hydrogen sulphide on aromatic ortho-dinitriles. Substituted phthalonitriles have been prepared and these have been converted to new substituted dithio-B-isoindigos and also to substituted phthalocyanines.

Further work has been done on a study of the action of dry hydrogen chloride on solutions of phthalonitriles with alcohols in benzene. Preliminary iminoether formation and subsequent ring closure have been shown; the product is the hydrochloride of 3-iminophthalimidine. The properties of this compound and similar compounds prepared from substituted phthalonitriles have been investigated; they have been shown to be readily hydrolyzed to the corresponding phthalimide and to react readily with aromatic amines with the elimination of ammonia giving substituted 3-iminophthalimidines.

Qualitative Detection of Nitrate Esters. N. Milford, Dept. of Chemistry, Dalhousie University, Halifax, N. S. (Read May 3, 1948). The chemistry of the nitric esters is quite incomplete. Research with this type of compound is usually limited to war stimulated interest in explosives. Modern explosives often include a number of nitrogen containing functional groups other than nitric esters. Satisfactory qualitative tests for nitric esters have been lacking.

A quick colour test has been found. The results are satisfactory in most cases but there are two exceptions. Compounds containing a nitrated aromatic nucleus and those with vicinal nitroxy groups do not respond. In the latter case this deviation was due to side reactions of the two adjacent nitroxy groups but the nature of this reaction is unknown.

The Oxygen Consumption of Developing Eggs of Salmo Salar. Isabella Wilmot, Dept. of Biology, Dalhousie University, Halifax, N. S. (Read May 3, 1948). This work is comprised of a study of the oxygen requirements of the developing eggs of Salmo salar. Measurements were made by the dropping mercury electrode assembly, the electrode being calibrated for concentrations of oxygen by the Winkler method of analysis. The rate of consumption was measured over a greater part of the prehatching period, and the effect of oxygen tension on the consumption was studied during the same time. A comparison of the limiting oxygen tensions in eggs acclimated at different temperatures was also made. The advantage of this method of analysis was that at any one stage in development, and using only a single sample of eggs, several measurements of the normal rate of consumption, and the effect of oxygen tension on it, could be made.

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Halifax]

PROCEEDINGS

OF THE

Nova Scotian Institute of Science

HALIFAX, NOVA SCOTIA

VOL. XXII. 1948-1949 PART 3

CONTENTS

Dedication to Dr. Ernest Hess iii

Faulting in the Vicinity of Halifax, Nova Scotia, H. L. Cameron... 1

New Records for the Distribution of certain Land Mollusca in Nova Scotia. Muriel J. Ord and Anne H. G. Watts 16

Presidential Address. C. C. Coffin 36

Proceedings of Meetings. Session 1948-49 38

Abstracts. (Papers read before the Institute but not published in the Proceedings) 42

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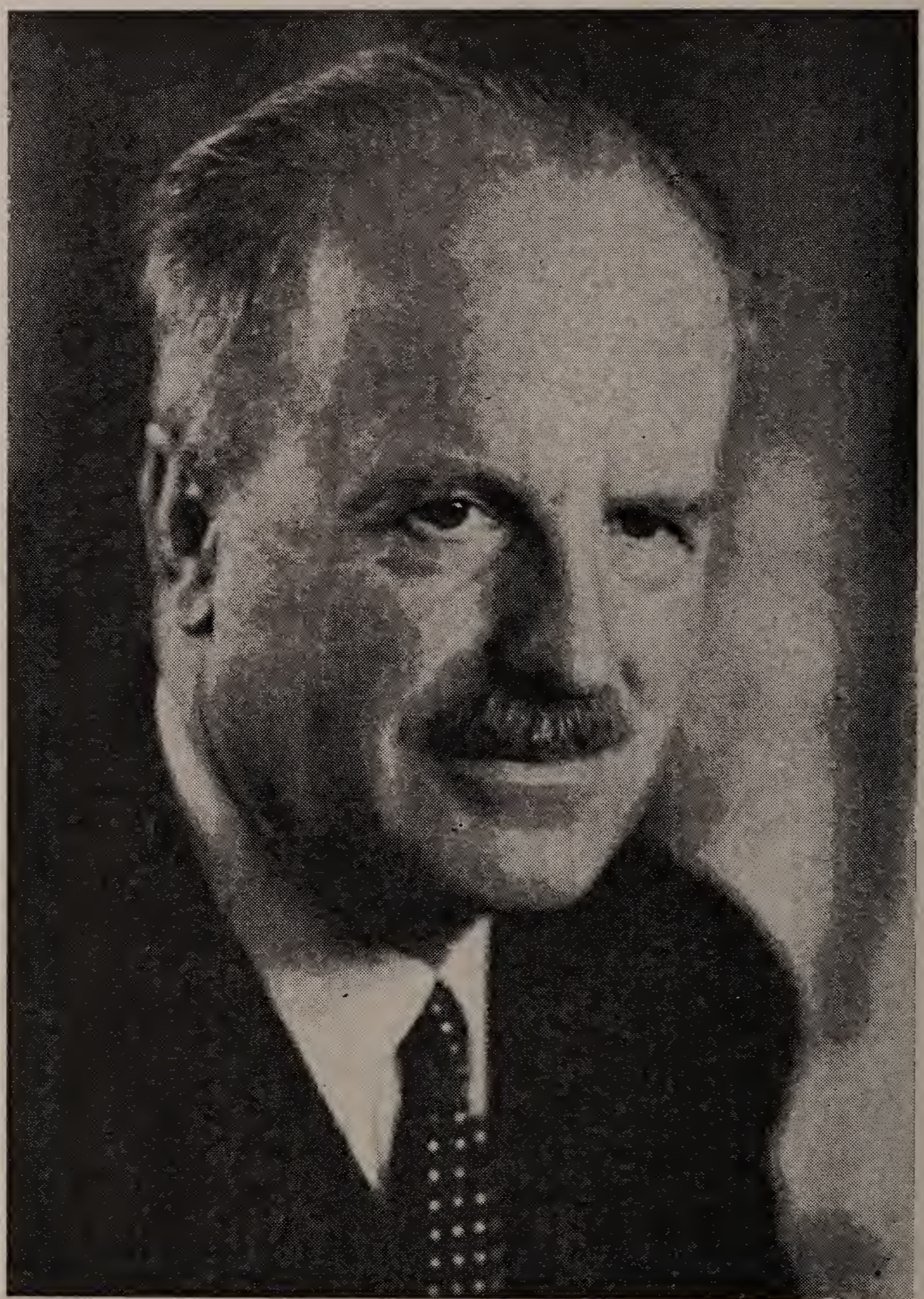

DR. ERNEST HESS

DEDICATION

This issue is dedicated to Dr. Ernest Hess as a mark of appreciation of the services that he has rendered as Editor of the Proceedings of the Nova Scotian Institute of Science.

Ernest Hess was born in Zurich, Switzerland, in 1897. During the First World War he served as a Lieutenant in the Swiss army, and in 1921 he graduated from the Swiss Federal Institute of Technology as "Ingenieur Agronome," majoring in Dairy Science. After some experience in dairy plants in Switzerland, he came to Canada in 1923. He worked in dairies in Canada and attended Queen's University, obtaining the degree of Master of Arts in 1925. He became a naturalized British subject in 1930. Following his graduation from Queen's University he was appointed an Assistant in Bacteriology at the newly established Atlantic Fisheries Experimental Station in Halifax, N. S., and became the Chief Bacteriologist in 1942. During his service with the Fisheries Research Board, he continued his graduate studies, and received the degree of Doctor of Philosophy from McGill University in 1933. In 1935 he was appointed an Associate Professor of Bacteriology, (Fisheries) at Dalhousie University. During the recent war he organized the Fish Inspection Laboratory in Halifax, and became its Director in 1947. In 1949, Canadian science was honoured by the appointment of Dr. Hess to the staff of the Fisheries Division of the Food and Agriculture Organization of the United Nations. Dr. Hess is, at present, stationed in Washington, D. C.

Dr. Hess has carried on bacteriological research on fresh and processed fish. He has done considerable work in canning, especially of lobster, and has done field work in cannery sanitation and quality control. He has published several scientific papers. He has done considerable educational work, from short courses to fishermen, fisheries inspectors, and cannery managers, to college courses at the fisheries schools of Dalhousie and Laval Universities.

In addition to the work outlined above, Dr. Hess has had many interests. He has become a member of the Society of

American Bacteriologists, the Professional Institute of the Civil Service, the Canadian Committee on Food Preservation, and the American Institute of Food Technologists. He has travelled extensively in Canada, the United States, and in Europe.

Dr. Hess became a member of the Nova Scotian Institute of Science in 1927, and was appointed Corresponding Secretary in 1931. From 1940 till his departure from Halifax in 1949 he has served as Editor. From 1938 to 1942 he served as Vice-President, and from 1942 to 1944 as President. In 1949 he was elected an Honorary Member. To these positions he brought not only his knowledge and skill, but a friendly interest and a conscientious attention to detail that has been of inestimable value to his fellow members. A considerable portion of the editorial work of the present issue has had the benefit of his guidance and assistance.

In this issue of their Proceedings the Nova Scotian Institute of Science wishes to express its grateful appreciation for the work of Ernest Hess during the many years that it has been privileged to have him as an associate, and it extends to him and to his family every good wish for the future in his new fields of endeavour.

PROCEEDINGS

OF THE

Nova Scotian Institute of Science

SESSION OF 1948-49
Vol. XXII, Part 3

FAULTING IN THE VICINITY OF HALIFAX, NOVA SCOTIA

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(Received for Publication: Dec. 22, 1948)

ABSTRACT

The Meguma Series east of Halifax has been extensively faulted in a NW—SE direction. The major faults were mapped by Dr. E. R. Faribault of the Canadian Geological Survey who did not state the exact age of the faulting. The present study based on aerial photograph interpretation has revealed the existence of at least twice as many minor faults as are shown on existing maps. A number of hitherto unmapped major faults were found in the immediate vicinity of Halifax, both in the granite and Meguma Series. The faults are briefly described. It is concluded that the faulting is post granite and hence post lower Devonian.

The glacial geology is briefly noted and a number of points mentioned for further study.

The major faults which cut the Meguma series east of Halifax have been mapped by the Geological Survey of Canada, mainly through the work of Dr. E. R. Faribault. The age of these faults has never been definitely stated, though in the case of the Indian Harbour fault, it was inferred that the old river valley of the St. Mary's River followed the fault and thus cut the Sherbrooke granite mass. This would give a post Lower Devonian age for the faulting. On the other hand, Malcolm (1928) p. 40, gives the succession of events as, folding, local and cross country faulting, and granite

intrusion. In pursuing a general study of faulting in N. S., the writer has made a check on all observable faults in the area from Canso to Bridgewater, as seen in aerial photographs. Some very interesting general results have been obtained, but the present discussion will deal only with the faults in the immediate vicinity of Halifax.

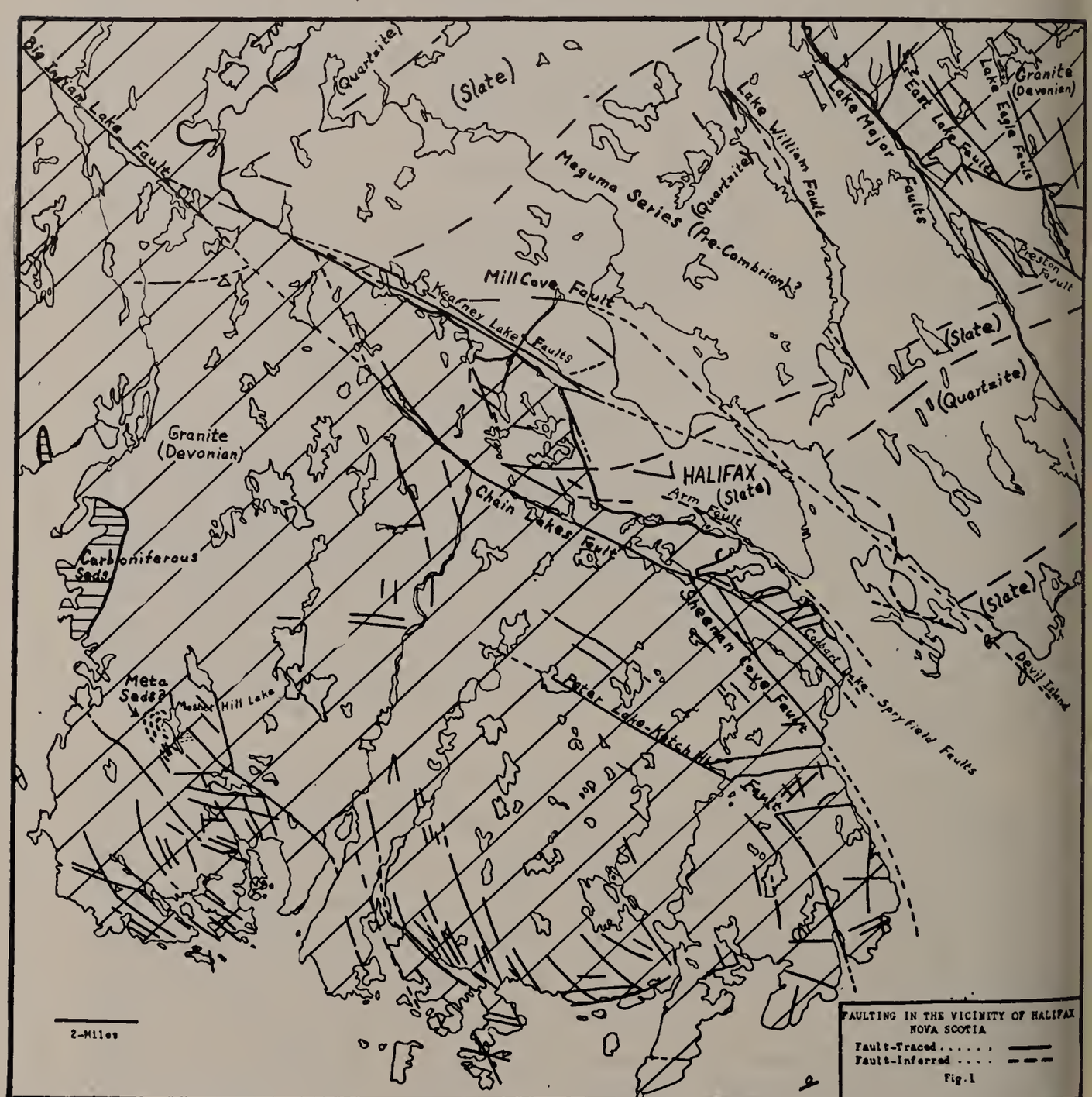

Figure 1

Figure 1 is a map of Halifax and vicinity showing the observed and inferred faults. The first point of interest is that a number of large faults cut the granite lobe west of Halifax and are quite obviously of the same age as those which cut the sediments. This fact is confirmed by many observations of the granite masses east of the map area. It can now be stated that the faulting is of post Lower Devonian and probably pre-Carboniferous age. Another interesting point is that the Meguma faults can now be definitely correlated with the Hollow-Cape George fault of the Arisaig area, and to one period of faulting in the Gaspe Area. Referring to Figure 1 the faults will be described, from east to west.

(1) *Preston Fault* (mapped by Faribault). Displaces the Dartmouth syncline near Preston. The change of direction is notable. It is probably due to the resistance of the granite mass to the north. The north section is approximately in line with one branch of the Lake Major fault, and is inferred to join it as shown. The displacement is left hand.

(2) L*ake Eagle Fault*(Aerial Photograph Interpretation). Extends from Tittle Lake to Eagle Lake. It meets the Preston fault near the lower end of Eagle Lake.

(3) *East Lake Faults* (Aerial Photograph Interpretation). Two parallel breaks which cut the granite and parallel the Lake Major fault to the west. They are not considered to be major faults. The major lines of faulting in this area are the Porter Lake and Lake Major faults.

(4) *Lake Major Faults* (Faribault and Air Photo-Interpretation). This fault or system of faults is the major fracture system in the eastern part of the area. It can be traced from Soldier Lake in the north to the coast at Cole Harbour. The north section follows the granite-sediment contact. A number of parallel

breaks occur both east and west, as (2) above, and the Pensey Head and Little Soldier Lake faults

(5) *Lake William Fault* (Faribault, Hind et al). This zone parallels the Lake Major fault, and where mapped has a relatively small displacement. It is believed that it extends southeast to the vicinity of Cow Bay, but heavy drift masks this section.

(6) K*earney Lake-Eastern Passage Faults* (Aerial Photograph Interpretation). This fault is of particular interest as it can be used to explain some local topography. The northwest section follows the granite-sediment contact from Taylor Lake to Kearney Lake. The fault continues South East from this point in an almost straight line, but the contact swings to the south with a branch fracture probably following it. The main break can be traced nearly to Rockingham where it is masked by drift. The inferred continuation parallels the Arm Fault and is supported by the discrepancies between the strike lines of the fold axis on opposite sides of Bedford Basin and Halifax Harbour. One final piece of evidence is the fault which cuts Devil Island southeast from Eastern Passage. To the North West this zone probably meets the fault which passes through Big Indian Lake.

(7) *Mill Cove Fault* (Aerial Photograph Interpretation). A fault which starts west of Paper Mill Lake and extends east to Mill Cove. It is inferred to curve south as shown to meet the Kearney Lake fault near George Island, to form a lozenge shaped segment. A fault has been mapped by Faribault as offsetting the Waverley anticline northwest of Kearney Lake. This may be a continuation of the Mill Cove Fault or may be an echelon fault giving a "green stick" fracture effect.

(8) *Arm Fault* (Air Photograph Interpretation). This fault parallels the Kearney Lake on the northeast and the Spryfield-Chain Lake faults on the southwest. It appears to die out near Armdale but probably increases in size to the southeast.

(9) *Colbart Lake-Spryfield Faults* (Aerial Photograph Interpretation). Two distinct breaks which are nearly parallel to the Arm fault. However, if the Arm fault follows the curve of the coast to Sandwich Point, these faults will converge to form another lozenge shaped segment. An interesting feature is the east-west cross faults between these faults and the Arm fault.

(10) *Chain Lakes-Sheehan Cove Faults* (Aerial Photograph Interpretation). This is believed to be the major fault zone of the central part of the area. It can be traced from Maple Lake in the northwest to Sheehan Cove and Chebucto Head in the southeast. A possible continuation to the northwest through Wright, Clay, and Big Indian Lakes would give this zone a length of thirty miles. The confirmed length of twenty miles places it in the same class as the New Harbour, Country Harbour, and West River Sheet Harbour faults.

(11) Faults in granite lobe southwest of (9)—(See Fig. 3e and 3f)—Those parallel to the NW-SE system include the Hackett Cove, Power Lake—Prospect Bay, and Ketch Harbour faults. A number of east-west fractures are associated with these breaks. A number of north-south adjustment (?) fractures are also present.

In addition to the foregoing there exist a number of local cross fractures which appear to be the ordinary grid jointing observed in many granite outcrops. Foliation parallel to some of the faults suggests that the granite may not have

been completely solid at the time of faulting. See Fig. 3b. This is not probable so the lineations may be considered as an indication of the intensity of the fracturing.

To briefly summarize; the major faults of the area belong to the great NW-SE system mapped in the area east from Halifax. The essential parallelism of the major breaks is slightly modified, probably due to the resistance of the granite masses and a number of lozenge shaped segments have developed. The movements all appear to be left hand and vary from a few feet to 3000′ and more.

An area was noted near Mosher Hill Lake that shows a pattern similar to areas of sediments included in the granite near Canso. This area will be ground checked and will constitute an interesting check on aerial photograph interpretation.

Incidental to the study of the faulting a number of facts were noted about the geological structure and glacial geology of the area. Figure (2) illustrates the general glacial geology. The distribution of drumlins and glacial ridges is shown. The denuded areas and the heavily drifted areas which occur immediately south of them give further evidence of the direction of ice movement. See Figs. 3a, 3b, 3c and 3d. A number of points suggest further studies; for example (1) why is the glacial drift southeast of Dartmouth arranged in ridges rather than in drumlin form as it is across the harbour to the west. (2) The ridges of drift in the valley of the Sackville River may be lateral moraines of a local valley glacier or elongated drumlins.

The fold structures of the Meguma sediments are shown clearly and completely in the aerial photographs. Fig. 3f shows the Bedford syncline with all its symmetry of line and form. Fig. 3c shows the fracturing and loss of symmetry where the granite intrusion comes in and faulting has occurred. Fig. 3e covers the area of suspected meta-sediments near Mosher Hill Lake.

In conclusion, the data presented in this paper was obtained mainly from the stereoscopic study of aerial photo-

Figure 2

graphs. However, it must be kept in mind that the interpretation was based on the experience of the writer on the ground in similar areas elsewhere in Nova Scotia, and on the study of many photographs of other areas keyed to ground data.

As photogrammetrist for the Nova Scotia Research Foundation, the writer wishes to thank the Foundation for the use of their Aerial Photograph Library and the plotting

stereoscope (Multiscope), and particularly for their encouragement in this project as an example of photogrammetry in pure science.

ILLUSTRATIONS

Fig. 1. Map of Faults in Vicinity of Halifax.

Fig. 2. Glacial Forms in Vicinity of Halifax.

Fig. 3. a. Aerial Photograph of Halifax.
b. Long Lake Area.
c. Kearney Lake.
d. Terrence Bay.
e. Mosher Hill Lake.
f. Bedford Syncline.

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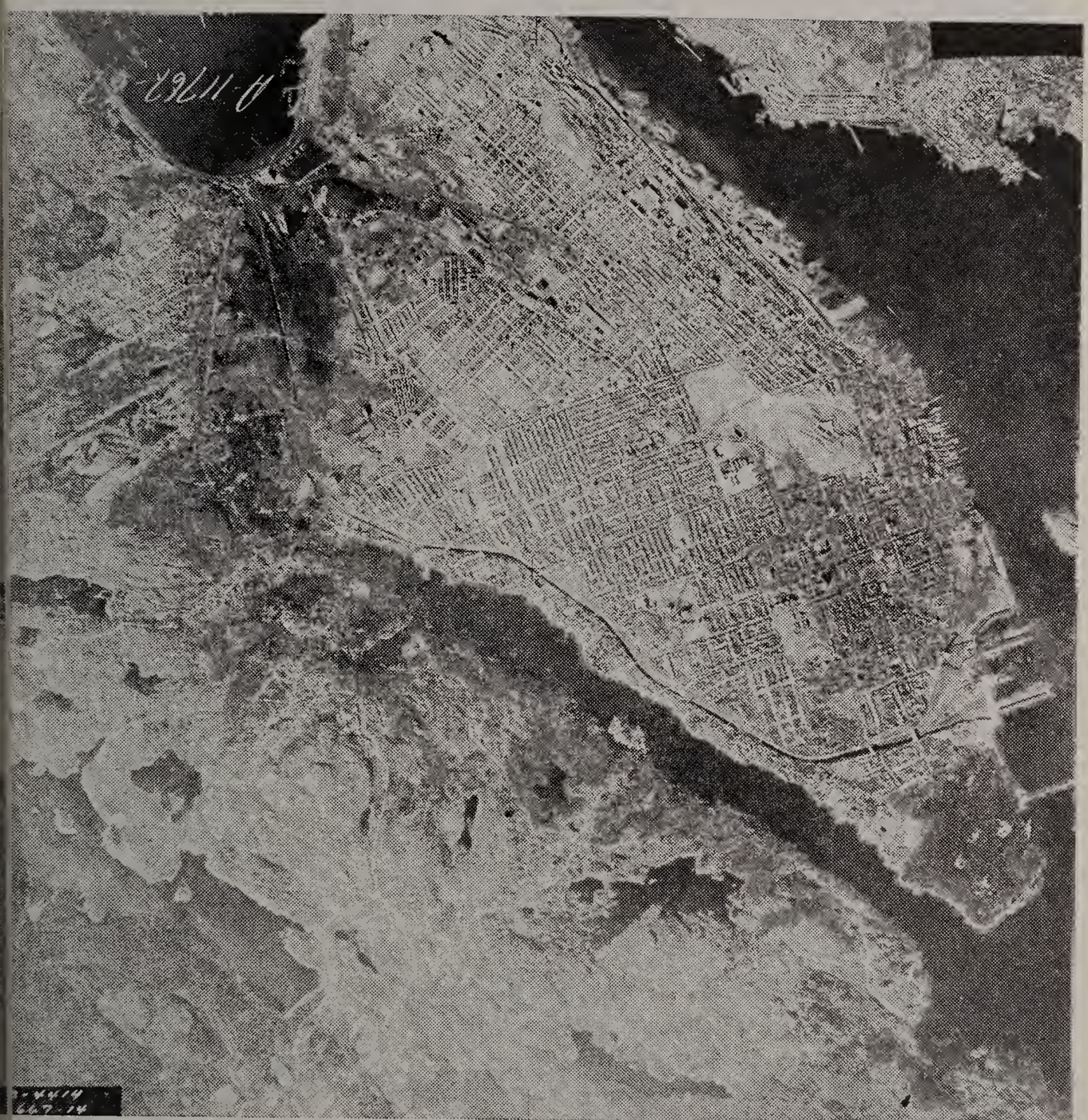

Figure 3-A

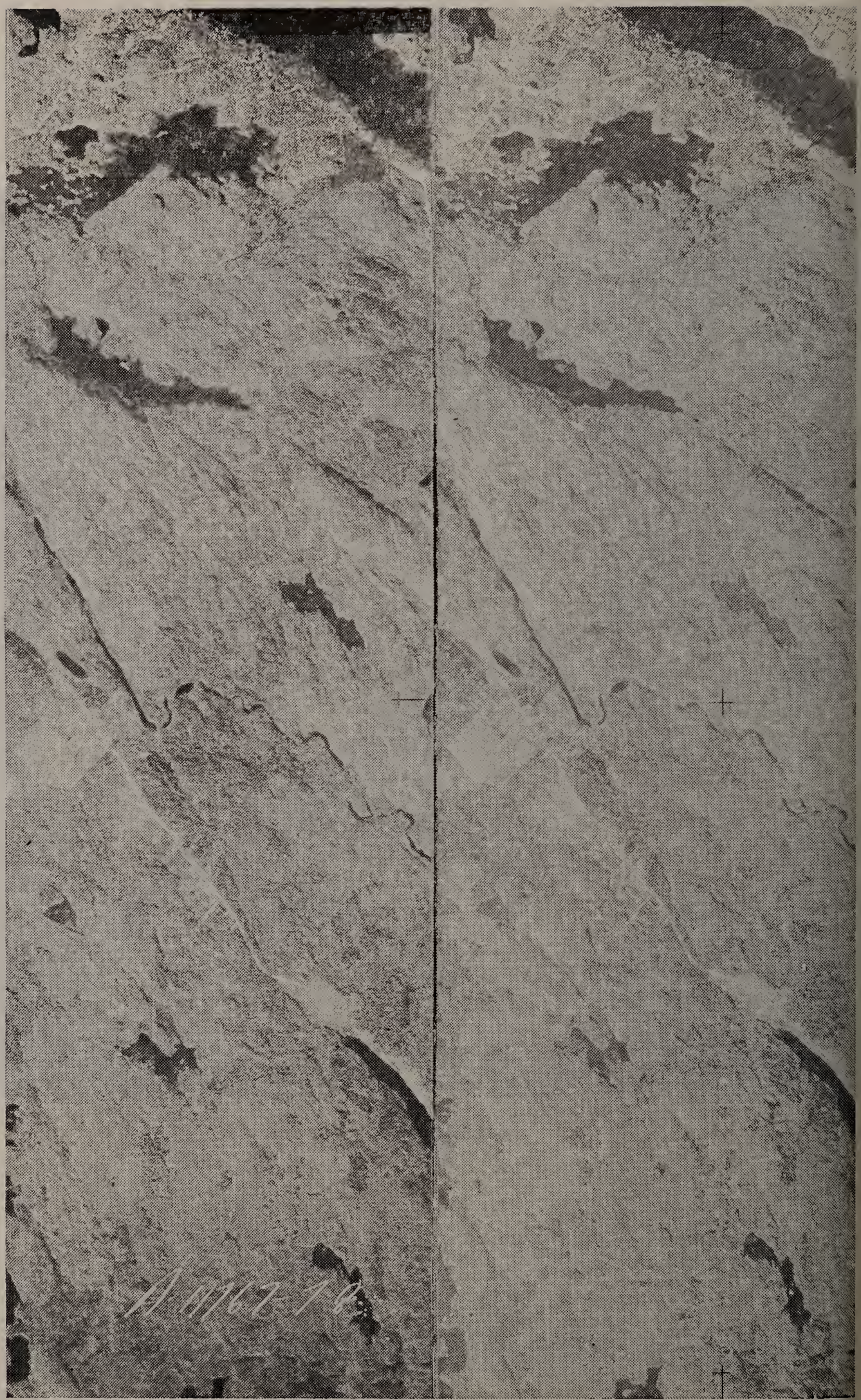

Figure 3-B (East)
(Stereo pair)

Figure 3-B (West)
(Stereo pair)

Figure 3-C

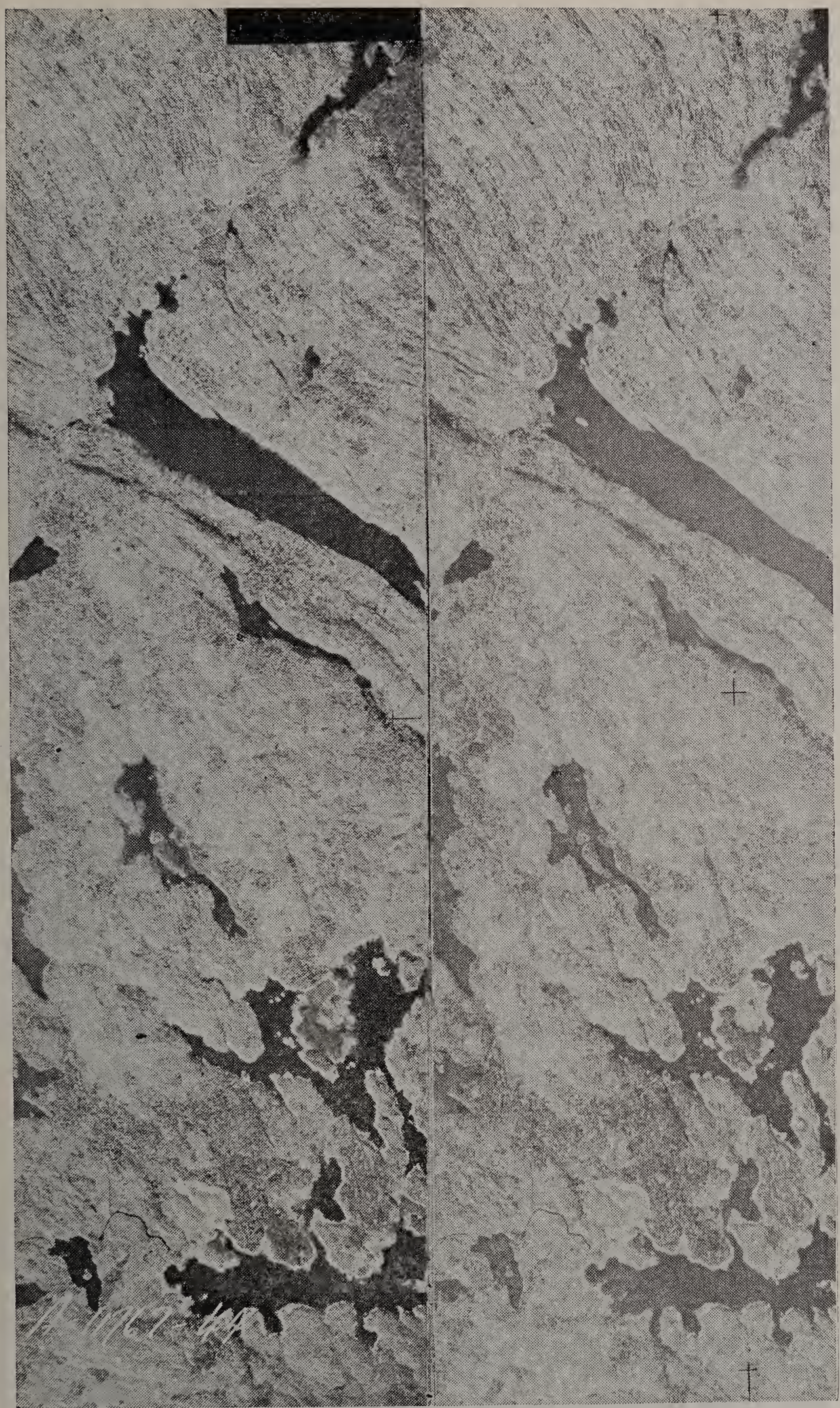

Figure 3-D (East)
(Stereo pair)

Figure 3-D (West)
(Stereo pair)

Figure 3-E
(Stereo pair)

NEW RECORDS FOR THE DISTRIBUTION OF CERTAIN LAND MOLLUSCA IN NOVA SCOTIA

By Muriel J. Ord and Anne H. G. Watts

Department of Biology

Dalhousie University, Halifax, N. S.

(Received Oct. 6, 1949)

ABSTRACT

The types of land mollusca of the families Arionidae and Limacidae found in Nova Scotia, particularly Halifax County, have been studied. Five species have been collected, only one of which, Arion circumscriptus, has, to the authors' knowledge, been recorded previously. This report contains descriptions of each species, including the external and internal anatomy, the laying periods and types of eggs, the normal environment, and any pecularities of habit which have been noted from seeing these animals in their natural habitat and from watching them in aquaria in the laboratory.

This paper deals with the species of land Mollusca which have no external shell, and which are commonly called slugs. In these pulmonates the shell is greatly reduced, and usually covered by a flap of tissue, the mantle. Of the many genera found in North America, representatives of only two, Arion and Deroceras, have been found in Nova Scotia, five species having been collected. Only one of these, *Arion circumscriptus*, has been reported previously to the authors' knowledge. This was collected in Morden and Berwick, King's County, by H. Griffiths of the Institute of Parasitology, MacDonald College, and recorded in a paper by A. LaRocque (1936).

The authors wish to take this opportunity to thank Dr. D. Pelluet, under whose guidance the work was carried out; Dr. H. A. Pilsbry and Mr. G. K. MacMillan, who identified the specimens; Miss Barbara Schwartz who assisted in the photography; Miss Hope Bridgeford who read the manuscript; and all those who aided in collecting the animals.

INTRODUCTION

A great deal of our collecting was done in Halifax County, although we have now done sample collecting in most of

Nova Scotia. We hope that the latter, combined with a fairly complete record for Halifax County, is enough to give a correct representation of the distribution of slugs in Nova Scotia. Collecting was usually done between 10.00 a.m. and 5.00 p.m., and because slugs are least active during these times, most were found beneath boards, stones and dead leaves. The few slugs which were found in the open belong to the genus Deroceras. We tried collecting in a number of different types of places, and found that *Deroceras laeve* was the only slug found far away from habitation. *Arion circumscriptus*, *hortensis*, and *subfuscus* were usually found in or near old ruins, the latter particularly under piles of old wood, while *Deroceras reticulatum* and, to a lesser extent *Arion circumscriptus*, were found mostly near inhabited buildings and gardens. Of these five species *Deroceras laeve* is the only species native to North America, the other four having been introduced from Europe (Pilsbry, 1947).

Samples of each species were brought back to the laboratory and kept in covered glass tanks. They were kept out of bright sunlight, aired daily, and fed on lettuce or cabbage leaves. The eggs were collected when laid and put into small glass containers where their progress could be watched. Later it was found more convenient to keep the animals in outdoor containers. These were wooden structures 4 feet long, 3 feet wide and 1 foot deep, partly buried in earth and with screening on the top and bottom.

A map of the distribution of all species in Nova Scotia is given, in addition to maps of the occurrence of each species in Halifax County which accompany the descriptions.

DEROCERAS

This genus, of which two species were found, belongs to the family Limacidae. Deroceras is separated from the rest of the family by having an intestine with four folds, two backwardly directed, the second being longer (Pilsbry, 1947).

A key to the figures will be found at the end of this paper.

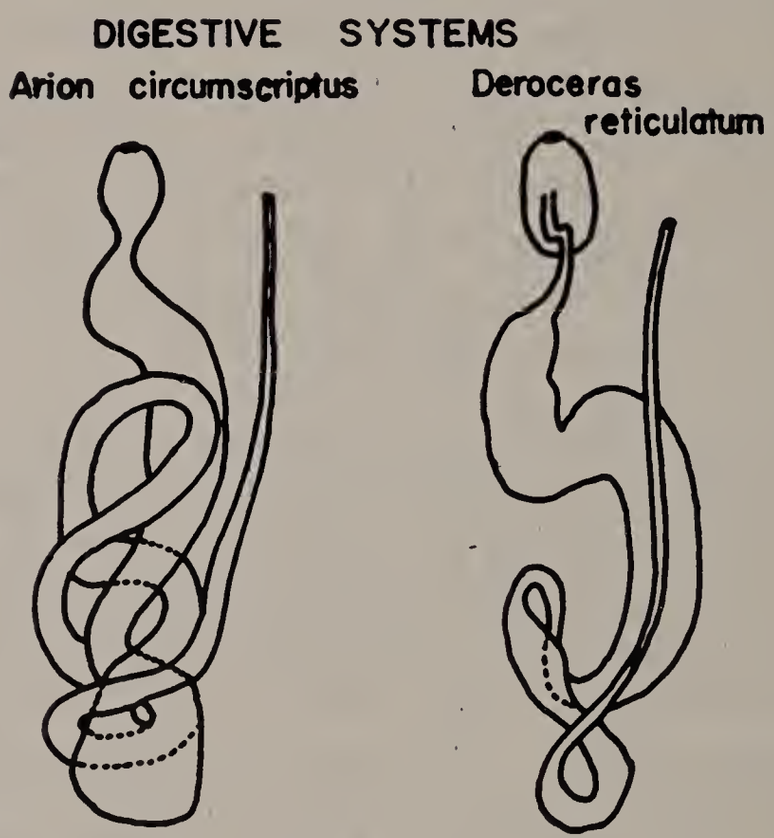

Figure 1

Deroceras reticulatum seems to be the most common slug in Nova Scotia. It has been found in almost all the places where we collected, except those away from habitation, and has been found in great numbers, crowded together, as many as a hundred specimens being found under one small board on several occasions. It is a medium sized animal, its colour varying from cream to very dark grey, and is often mottled. The tentacles are light and the foot is tripartitely coloured, the middle section being darker. It has clear slime when travelling along untouched, but if irritated in any way gives off a milky white slime. This gives it a glistening appearance, and makes it moist to the touch, whereas the Arionidae feel almost dry, although slightly sticky. Dissected specimens, when mature, show a very large ovotestis, dorsally situated and wrapped in lobes of the digestive gland. The penis is divided in three, the last division being a finger-like gland situated just beyond the entrance of the vas deferens. The seminal receptacle is long, becoming wider towards the

posterior end, and attached along a good deal of its length to the free oviduct (Pilsbry). The hermaphroditic duct is short.

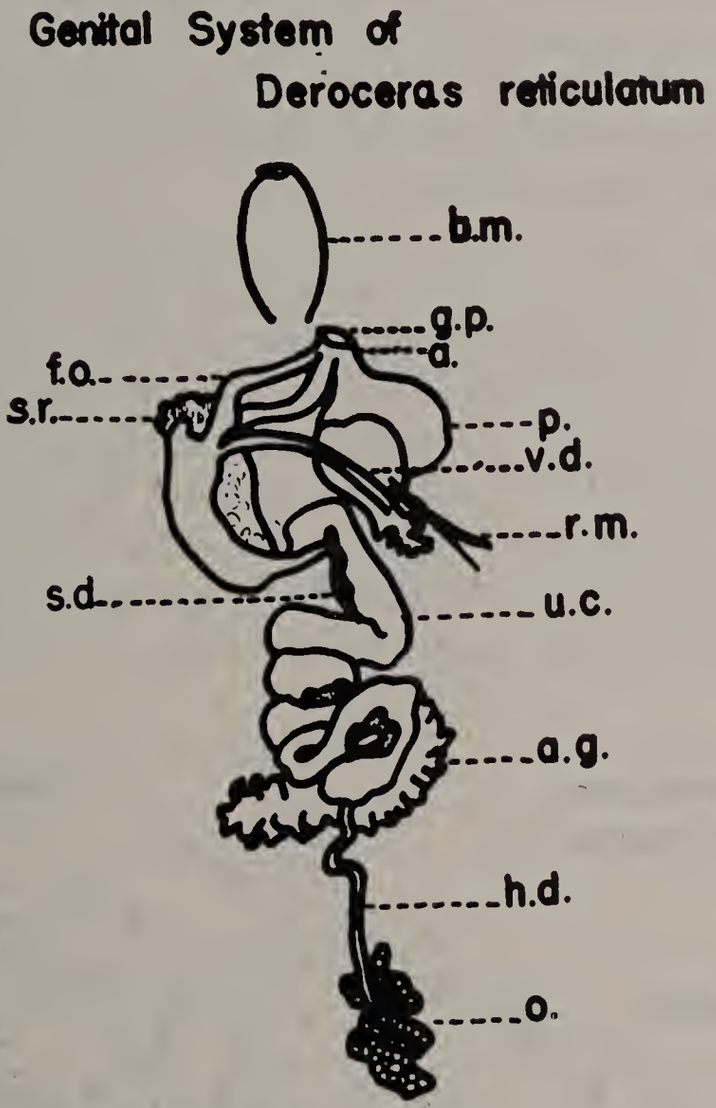

Figure 2

Deroceras reticulatum lays a great number of eggs, almost continually throughout the year. Eggs have been found outdoors from March until December. The eggs are usually laid in clusters, the number of eggs in a group varying from several to fifty or more, although the average clusters have ten to fifteen eggs. Occasionally eggs are found in ones and twos, especially near the end of a breeding season. The eggs are small and transparent, and generally round in shape, about 1.5 mm. in diameter, although large oval eggs with a

length of 2 to 2.5 mm. have been found. They are usually a little beneath the ground in our tanks, and outdoors are found under wood or stones with the slugs themselves. They hatch anywhere from about four days to three weeks into the tiny, pinkish, almost transparent young. There is no regularity in the rate of development and growth, embryos of the same age, and young of the same age often being in different stages and varying greatly in size.

This slug is the one with which almost any Nova Scotian who has had anything to do with gardens is familiar, as it is very active, and on some occasions is found travelling about or eating in daylight. It is much more of a garden slug than *Deroceras laeve* or the Arionidae; the former is more common away from habitation, the latter, at least during the daytime, never being found on plants. *D. reticulatum* was always found near some signs of habitation, generally under cover of anything from boards to old rubber tires, on the ground or in grass.

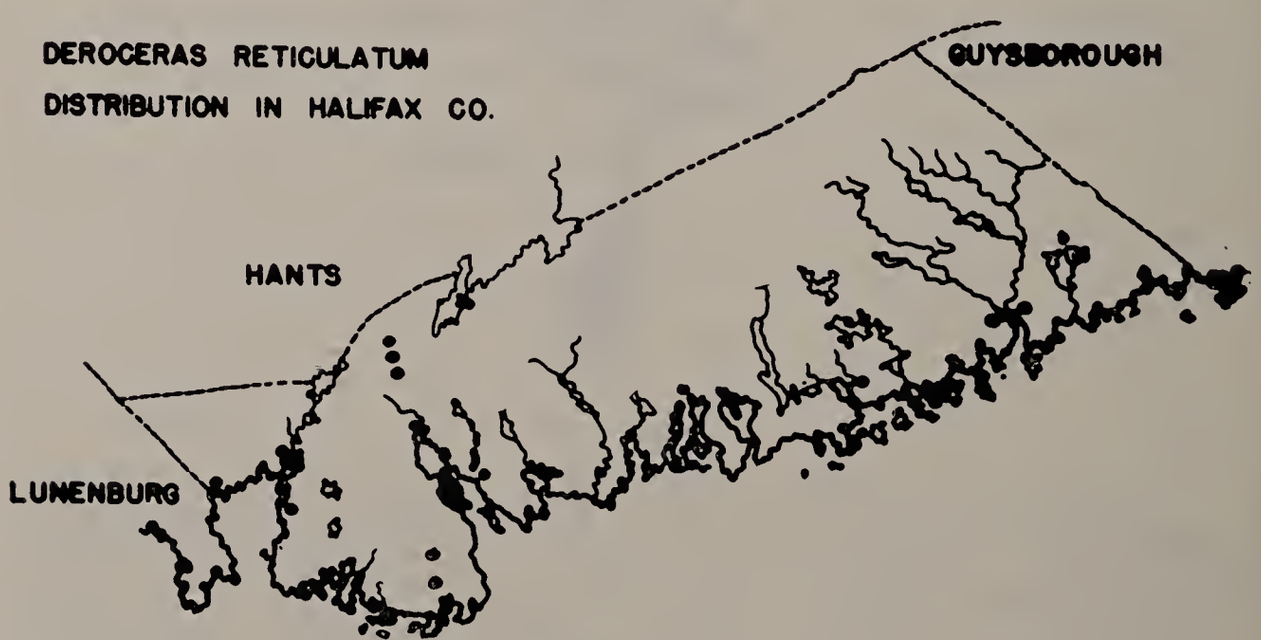

Figure 3

Deroceras laeve. This is the only native species which we have obtained during our collecting trips. It has been found far away from habitation as well as in farm pastures and occasionally country gardens. *D. laeve* is a small animal, our largest specimens being approximately 2.5 cm. in length when moving. It varies in colour from creamish to almost

black, with a greyish foot. Its neck, which it retracts beneath a small oval mantle, is longer than that of other species we have collected. Like *D. reticulatum*, it is wet to the touch, being covered with a thin coat of clear slime. This species can be distinguished externally from *D. reticulatum* by the white slime which the latter excretes when irritated. On dissection (a number of specimens having been tried) only the female parts of the reproductive systems were found to be present

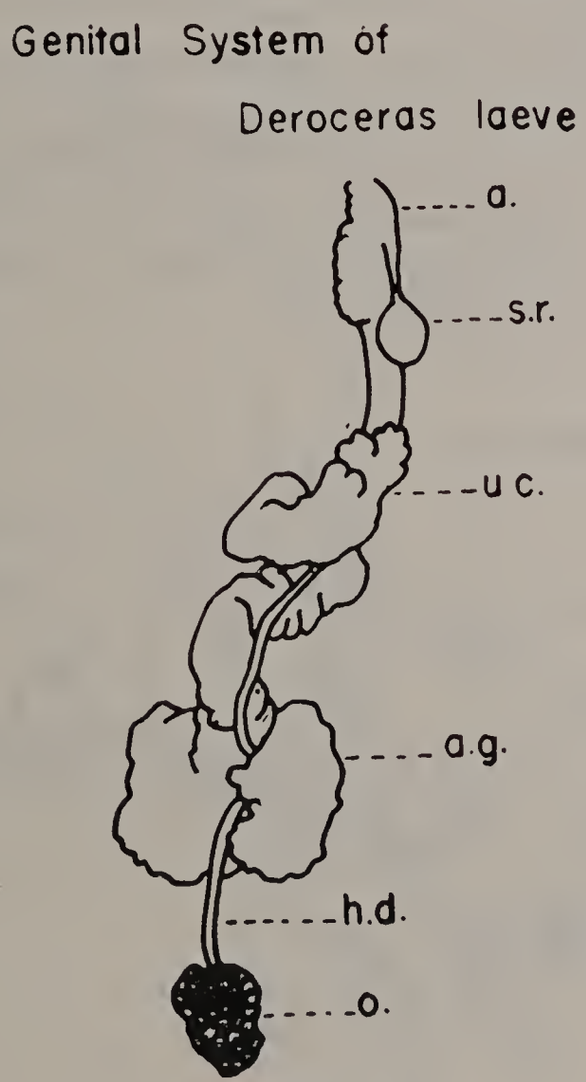

Figure 4

(late October). The ovotestes from these were taken out and smeared in acetic orcein, and sperms were found to be present in all, so that the system is not wholly female. The specimens used were ones which had just reached their full growth, and were at that time laying eggs. The ovotestis is small and hidden in the lobes of the digestive gland. The hermaphroditic duct is short, and the seminal receptacle globular. Self fertilization has been noted in this species.

Deroceras laeve has much the same laying period as *D. reticulatum*, eggs being laid spasmodically all summer. The eggs are laid in twos, threes, and small clusters, not usually more than eight or ten being found together. These, like *D. reticulatum* eggs, are small and globular, about 1.5 mm. in diameter, and cannot be distinguished from the latter. The young are greyish and quite transparent and grow very quickly.

These animals are found with their eggs in grass or moss under wood. They seem to prefer damp places, one specimen being found submerged on Potamogeton in the Gaspereau River. They are very active. However, they do not seem to be destructive to gardens, very few ever having been found there, and none being found in Halifax or Dartmouth, where much collecting was done.

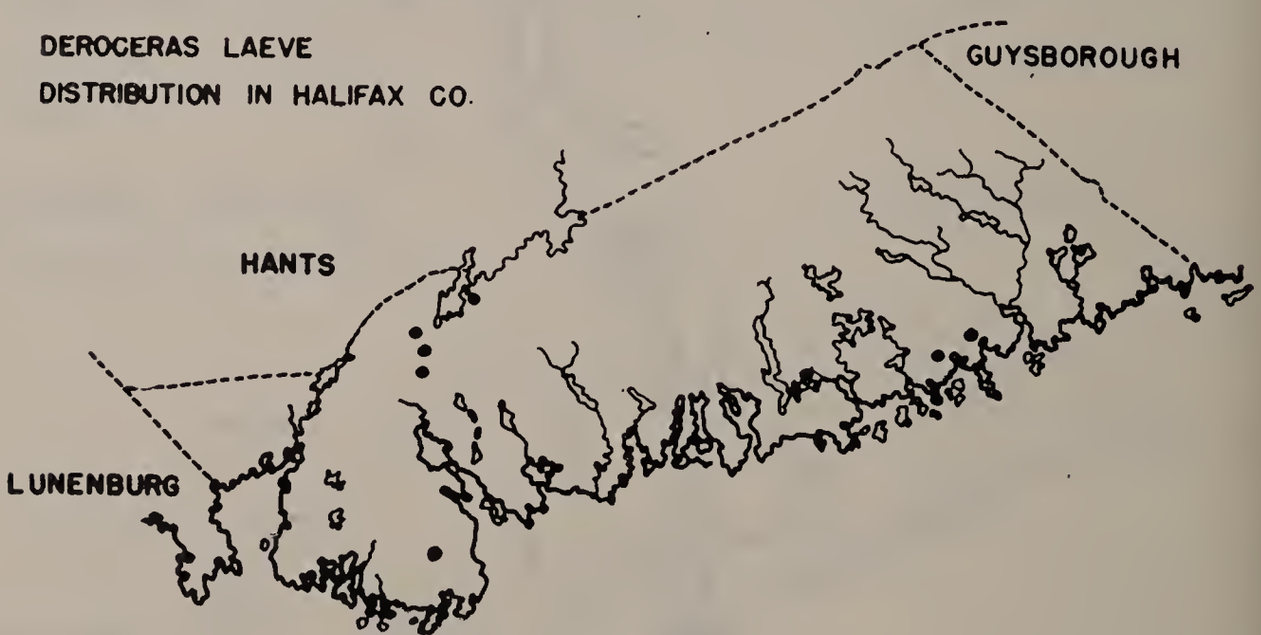

Figure 5

ARION

This genus belongs to the family Arionidae, and three species of Arion, *Arion circumscriptus*, *hortensis*, and *subfuscus*, were collected. The Arionidae are distinctive in having no penis (Pilsbry), no dorsal keel, a wide foot margin, and in being rather flatter than Deroceras.

Arion circumscriptus. This slug seems to be the most common species of the family Arionidae in Nova Scotia. It was found almost everywhere we collected (but not in such large numbers as *D. reticulatum*), except for those places which were far away from buildings or other marks of civilization, where only our native *D. laeve* was found. *Arion circumscriptus* is a medium sized slug, varying in length from 2 to 5 cm. when moving. Its colour varies somewhat from grey to sandy with two black longitudinal stripes, which may or may not have a slight orange colour bordering them. The

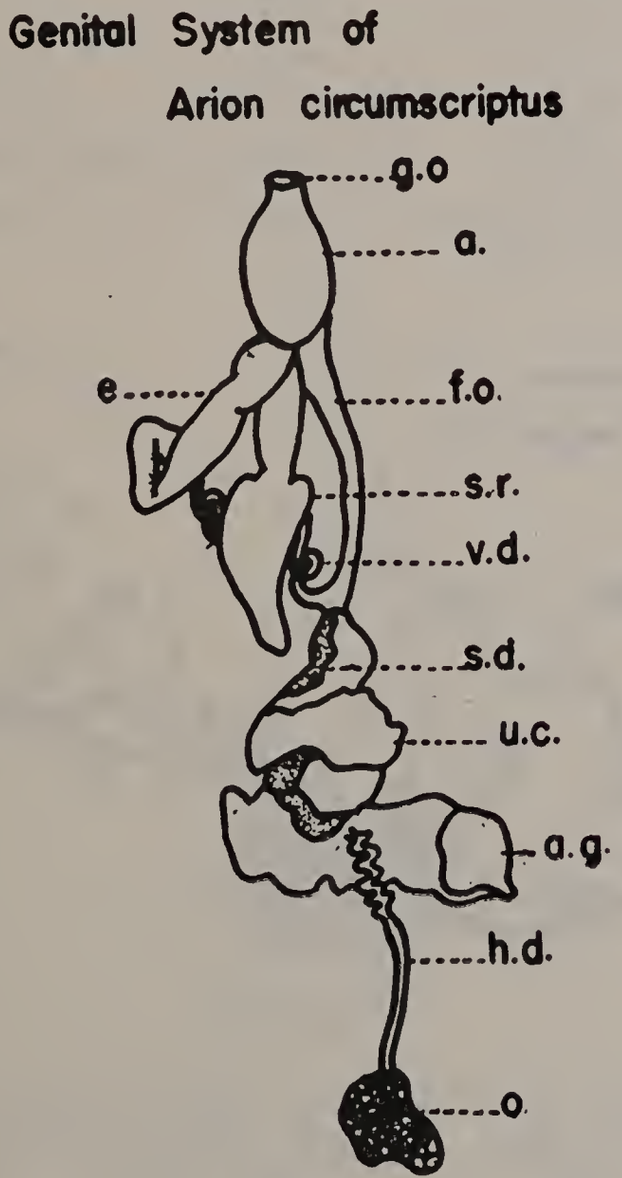

Figure 6

head and tentacles are black, and the foot very white. Their slime is clear and colourless. On two occasions light chestnut

and violet coloured specimens were found (Point Pleasant Park, Halifax, and Mt. Denson, King's Co.). In specimens which were dissected the seminal receptacle was pear shaped, the hermaphroditic duct long, the ovotestis, which is slow in developing, small, the free oviduct long and stout, and the atrium large. There was no penis, and in some specimens the passing of the vas deferens into the epiphallus was quite distinct, while in others it was hardly distinguishable.

The eggs of this animal were found in the spring and also during the early fall. They are yellow or orange in colour, their length varying from 2 to 2.5 mm. and the width from 1 to 1.5 mm. They are usually laid in two's or three's, although sometimes in clusters, with very little protection, often being on top of the ground. The young, which grow more slowly than those of Deroceras, are bluish in colour, gradually showing their black stripes.

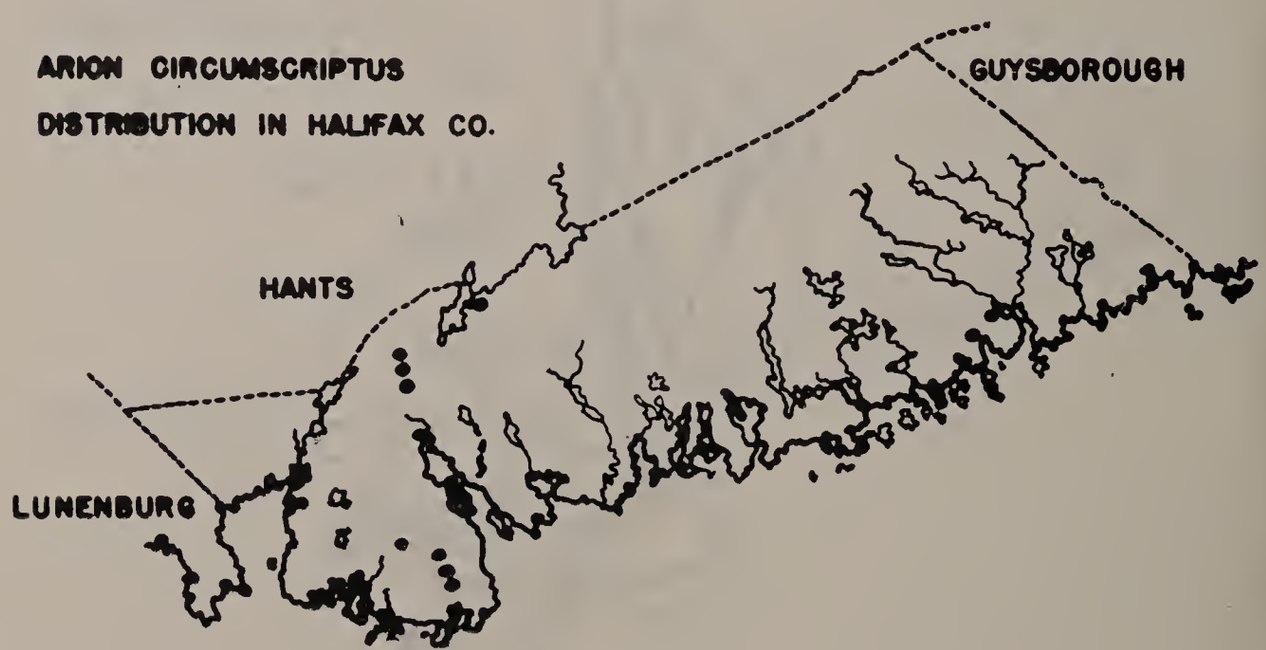

Figure 7

Most of the specimens we collected were found on the ground under boards. During the summer they were never found active in the daytime— but always in a resting position.

Arion hortensis is not a very common species in Nova Scotia, having been found on only a small percentage of our collecting trips, and never in large numbers. Its distribution to our knowledge is very limited. This is rather a small sized animal, black or very dark in colour, sometimes with darker lateral bands, and with dark head and tentacles. An out-

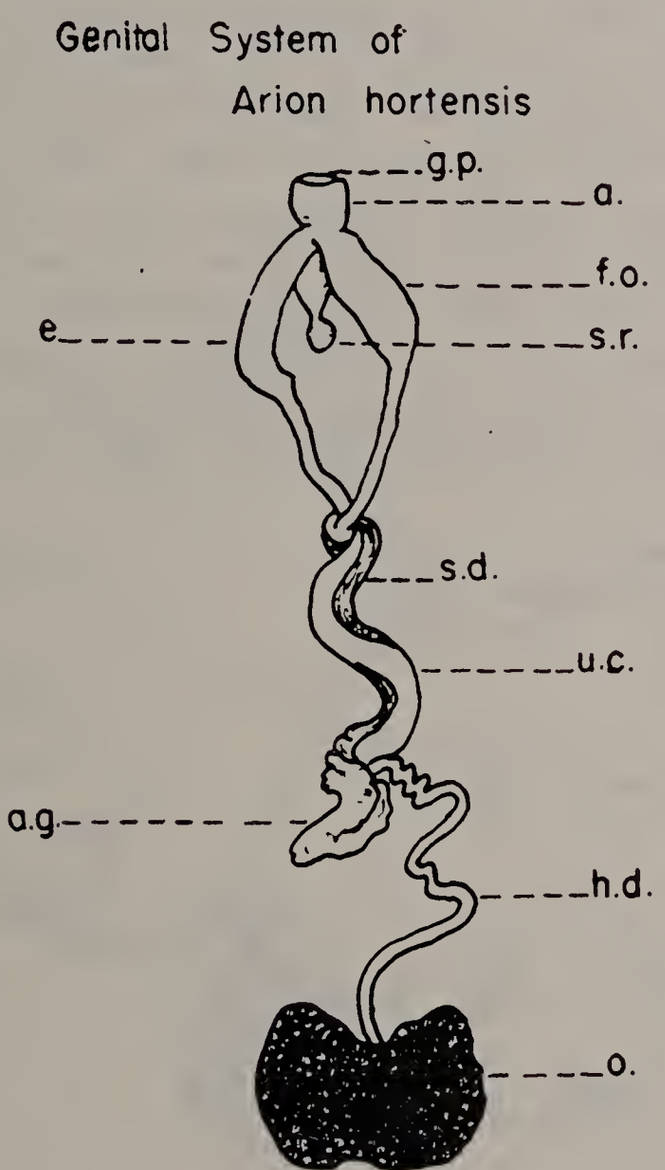

Figure 8

standing characteristic is the shade of its foot, which varies from light yellow to a deep orange. It is generally about 2 to 3 cm. in length. The slime is clear and colourless, but when much irritated the animal sometimes secretes from the foot a small amount of slime which is bright yellow. Partic-

ular characteristics of the genital system are the very long hermaphroditic duct, the long free oviduct, which is very stout at the anterior end, and the short atrium. The vas deferens passes almost unnoticeably into the epiphallus, with no penis, and the seminal receptacle is globular with a stout duct (Pilsbry).

This slug does not seem to be as prolific as our other species, very few eggs ever having been found. In spite of the fact that we had adults in tanks from May until November, only one lot of eggs has ever been laid. This was a group of ten eggs, about 1.5 mm. in diameter and whitish in colour, which were found at the end of June. All ten, after six days, hatched into bluish coloured young, and eight are still alive, having reached a length of about 8 mm. after five months of growth. In the field, although we found eggs of each of the other specimens, no *A. hortensis* eggs were ever collected.

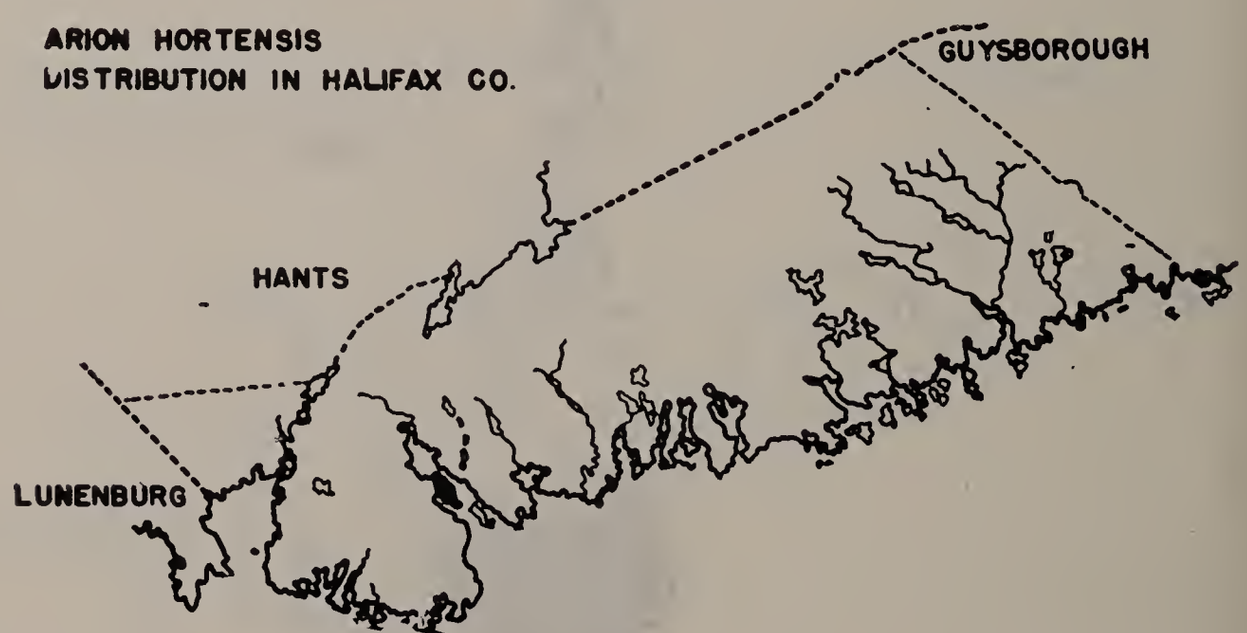

Figure 9

Arion hortensis is usually found among old and decaying leaves, although occasionally on the ground under boards. It has been found particularly around old houses, seldom choosing vegetable gardens. These slugs bury themselves a great deal of the time, and are usually found in a quiescent position (folded head to tail).

Arion subfuscus. Animals of this species are the largest which we have found. *A. subfuscus* is fairly common in distribution, although it is entirely absent in some districts. Our largest specimens are about 10 cm. in length and 1.5 cm. in width when moving. They are mostly a bright yellow or orange when collected, but many, after a few weeks in the

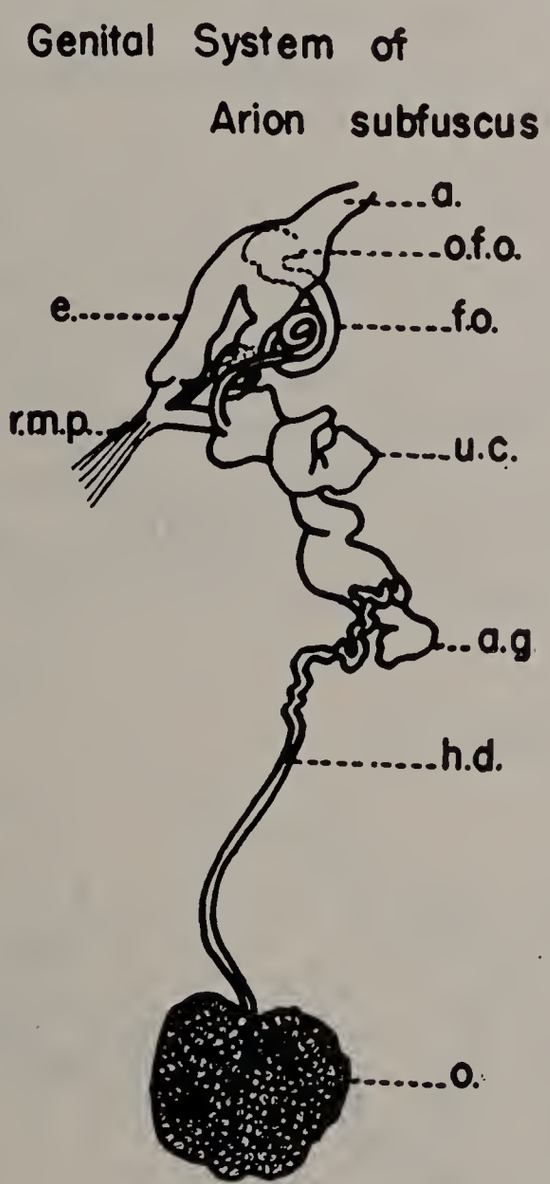

Figure 10

laboratory become greyish white, only their mantle remaining yellow. Faint grey lateral bands which are present in most, can be seen much more clearly after the bright yellow colour has disappeared. The foot is whitish with marginal fringes. The breathing pore is large. This animal secretes a thick

yellow mucus when irritated, but when untouched it leaves behind glistening tracts of clear slime. The head and tentacles are straw coloured. When dissected the ovotestis was found to be large and the hermaphroditic duct long. The seminal receptacle is globular and its duct becomes very stout before entering the atrium. The vas deferens is short and there is a very definite division where it enters the epiphallus. The muscles of the epiphallus and the seminal receptacle are noticeable. The free oviduct is long, and there is a definite globular swelling before it enters the atrium.

Eggs of *Arion subfuscus* have been collected outdoors in June, and also in the last few weeks of August. These eggs are white or pale yellow, opaque, about 2.5 mm. in diameter and laid in clusters of approximately twenty which are stuck tightly together with mucus. They are either attached to the walls of the containers or leaves by slime, or left on top of the ground. After laying their eggs these slugs soon die. The young are sandy in colour, and once hatched survive well.

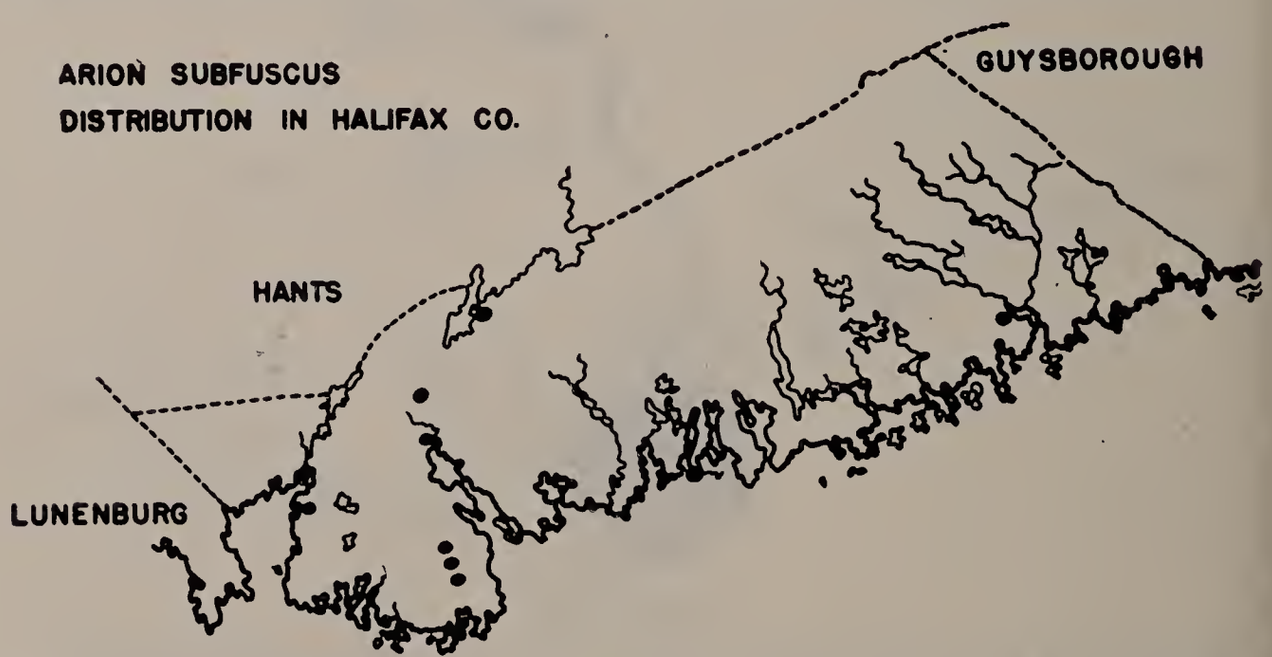

Figure 11

This species of land Mollusca is found mostly under wood piles, among rotting wood, or in manure, away from plants or ground where most of the other specimens were found. However, in the autumn specimens have been observed in

the open during the day. Besides having a large appetite for lettuce and other greens, *A. subfuscus* ate large quantities of brown gummed paper from the edges of the containers. In addition, members of this species show a strong tendency towards eating the muscular wall of their own dead.

Figure 12

Table I records the results of collections made in Nova Scotia. On the map of Nova Scotia (Fig. 12) are marked the places where collections were made outside Halifax County. The latter has been shaded in, since collections made in this area have been indicated on the maps which accompany the descriptions of the species. The collections made in Cape Breton have not been recorded on this map.

TABLE I

Date	Place	Per Cent of Total Number of Animals Obtained in Search				
		Deroceras Reticulatum	Deroceras Laeve	Arion Circumscriptus	Arion Hortensis	Arion Subfuscus
1948						
May 14	Old garden, Halifax north	20	..	40	40	..
" 20	Old garden, Halifax south	75	..	25	..	..
" 24	Old garden, Halifax north	30	..	..	70	..
" 27	Marlborough Woods, Hfx. Co.	25	..	30	45	..
" 29	Upper Sackville, Hfx. Co.	35	65	..	..	..
" 29	Middle Sackville, Hfx. Co.	..	..	100	..	..
Jun. 3	Marlborough Woods, Hfx. Co.	..	..	25	75	..
" 16	Fort Cambridge, Pt. Pleasant, Hfx.	25	..	65	10	..
" 17	Fort Cambridge, Pt. Pleasant, Hfx.	50	..	48	2	..
" 18	Fort Cambridge, Pt. Pleasant, Hfx.	45	..	55	..	..
Jul. 3	Sackville, Hfx. Co.	17	10	25	..	48
" 10	French Village, Hfx. Co.	..	..	65	..	35
" 15	Silver Lake, Sambro Rd., Hfx. Co.	..	..	95	..	5
" 19	Bedford, Hfx. Co.	65	..	22	12	1
" 20	Black Lake, Sambro Rd., Hfx. Co.	22	15	45	..	18
" 22	Oakfield, Grand Lake, Hfx. Co.	80	5	5	..	10
" 27	Doyle Lake, Sambro Rd., Hfx. Co.	20	75	..	..	5
" 29	Farm, Big Indian Lake Rd., Hfx. Co.	..	..	100	..	..
Aug. 12	Windsor Rd., Hants-Hfx. Co. Line	..	..	..	..	..
" 14	Copper Lake, Antigonish Co.	65	..	35	..	..
" 19	Musquodoboit Harbour, Hfx. Co.	100	..	..	..	..
Sep. 2	Wallis Station, Cumberland Co.	..	100	..	..	..
" 3	Oxford Junction, Cumberland Co.	..	100	..	..	..
" 11	Petite Riviere, Lunenburg Co.	42	..	58	..	..
" 15	Upper Sackville, Hfx. Co.	35	65	..	..	..
" 15	Middle Sackville, Hfx. Co.	35	65	..	..	..
" 19	Petite Riviere, Lunenburg Co.	75	..	..	..	25
" 22	Mount Denson, King's Co.	90	..	10	..	..

TABLE I—*Continued.*

DATE	PLACE	Per Cent of Total Number of Animals Obtained in Search				
		Deroceras Reticulatum	Deroceras Laeve	Arion Circumscriptus	Arion Hortensis	Arion Subfuscus
Sep. 22	Aylesford, King's Co.	97	..	..	..	3
" 24	Petite Riviere, Lunenburg Co.	..	..	100	..	..
Oct. 1	Sheet Harbour, Hfx. Co.	90	..	5	..	5
" 1	Spry Bay, Hfx. Co.	..	20	80	..	..
" 1	Pleasant Bay, Hfx. Co.	..	100	..	..	..
" 1	Ship Harbour, Hfx. Co.	100	..	..	..	..
" 1	Lake Charlotte, Hfx. Co.	..	100	..	..	..
Nov. 6	Old Garden, Halifax north	17	..	67	16	..
" 6	Garden, Dartmouth, Hfx. Co.	100	..	..	..	..
" 28	Garden, Halifax north	25	..	18	57	..
	(3 albino)					
Dec. 7	Garden, Halifax	92	..	8	..	..
1949						
Mar. 29	Fort Cambridge, Halifax	80	..	20	..	..
Apr. 5	Garden, Hfx. south	100	..	..	..	..
May 15	York Redoubt, Hfx. Co.	20	..	..	..	80
" 15	Bear Cove, Hfx. Co.	35	30	35	..	..
Jun. 14	East Chester, Lun. Co.	20	..	20	20	20
" 28	Hubley's, Hfx. Co.	75	1	9	..	15
Jul. 7	Maitland, Lun. Co.	30	20	20	..	30
" 7	Mossman, Lun. Co.	5	..	5	..	90
" 8	Pinehurst, Lun. Co.	30	10	60	..	..
" 8	Caledonia, Queen's Co.	37	1	2	..	60
" 8	New Germany, Lun. Co.	5	5	10	..	80
" 8	Waterville, Kings Co.	..	..	50	..	50
" 8	Gaspereau, Kings Co.	75	..	25	..	..
" 8	Newport, Hants Co.	40	..	30	..	30
" 8	Windsor, Hants Co.	60	..	20	..	20

TABLE I—*Continued.*

DATE	PLACE	Per Cent of Total Number of Animals Obtained in Search				
		Deroceras Reticulatum	Deroceras Laeve	Arion Circumscriptus	Arion Hortensis	Arion Subfuscus
1949						
Jul. 12	Lawrencetown, Hfx. Co.	44	11	..	..	45
Aug. 10	Copper Lake, Antigonish Co.	85	7	8	..	..
" 10	So. River Lake, Antigonish Co.	40	..	..	..	60
" 10	Glencoe, Guys. Co.	25	..	..	..	75
" 10	Grant Lake, Guys. Co.	30	..	..	..	70
" 12	Aspen, Guys. Co.	60	..	20	..	10
" 12	Denvar, Guys. Co.	75	25	..	..	..
" 12	Eden Lake, Pictou Co.	100	..	..	..	..
" 12	Glenelg, Guys. Co.	75	..	25	..	..
" 12	Willowdale, Pictou Co.	40	..	60	..	..
" 12	Stillwater, Guys. Co.	..	..	100	..	..
" 12	Sherbrook, Guys. Co.	95	..	5	..	..
" 12	Goldenville, Guys. Co.	50	50	..	..	..
" 12	South Lochaber, Guys. Co.	75	25	..	..	..
" 12	Eight Island Lake, Guys. Co.	80	20	..	..	..
" 12	Country Harbour, Guys. Co.	100	..	..	..	..
" 12	Storemont, Guys. Co.	60	20	20	..	..
" 12	Loch Katrine east	25	..	..	..	75
" 12	Loch Katrine west	100	..	..	..	..
" 5	St. Margarets, Hfx. Co.	20	..	5	..	75
Jul. 26	Petite Riviere, Lun. Co.	50	40	5	..	5
" 9	West Dublin, Lun. Co.	80	20	..	..	..
Aug. 12	Rocky Mt., Pictou Co.	75	25	..	..	..
" 12	Garden of Eden, Pictou Ca		100	..	..	..
	Cape Breton					
Sep. 8	Port Hawkesbury	8	..	..	..	92
" 8	Port Hastings	79	..	..	..	21
" 8	Long Point	100	..	..	..	..

TABLE I—*Continued.*

Date	Place	Per cent of Total Number of Animals Obtained in Search				
		Deroceras Reticulatum	Deroceras Laeve	Arion Circumscriptus	Arion Hortensis	Arion Subfuscus
1949						
Sep. 8	Judique	98	2	..	..	..
" 8	Glencoe	25	75	..	..	..
" 8	Dunvegan	94	6	..	..	..
" 8	N. E. Margaree	99	1	..	..	..
" 8	Finlayson	80	20	..	..	..
" 9	Baddeck	98	..	2	..	..
" 9	New Ross	50	50	..	..	..
" 9	Boularderie Island	92	..	8	..	..
" 9	Louisburg	64	22	9	..	5
" 10	Sydney River	93	..	..	..	7
" 10	East Bay	92	..	8	..	..
" 10	Big Pond	100	..	..	..	..
" 10	Irish Bay	100	..	..	..	..
" 10	Soldiers' Cove	100	..	..	..	..
" 10	River Bourgeois	50	..	..	..	50
" 10	Louisdale	100	..	..	..	..
" 10	Oban	30	70	..	..	..
" 10	The Points, West Bay	100	..	..	..	..
" 10	Marble Mountain	74	26	..	..	..
" 10	Malagawatch	87	9	1	..	3
" 11	Whycocomagh	100	..	..	..	..
" 11	Melford	46	54	..	..	..
" 11	Glendale	90	5	5	..	..
" 11	Kingsville	20	7	2	..	71
" 11	Mulgrave	75	..	..	..	25
" 11	Bayfield Road	96	4	..	..	..
" 11	Sutherland River	100	..	..	..	..
" 11	West River	68	32	..	..	..
" 11	Truro	100	..	..	..	..

CONCLUSION

In this paper we have attempted to set down the information which we have obtained by observation of certain land Gastropods of Nova Scotia. In addition to the five species described above, a possible sixth was observed by several people at French Village in Halifax Co. in the summers of 1945 and 1948, and at Grand Lake, Halifax Co., in the summer of 1947. This type, about 8.5 cm. long and pale creamy yellow in colour, has not as yet been collected and identified.

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EXPLANATION OF PLATE I

A. Deroceras reticulatum with eggs
B. Deroceras laeve with eggs
C. Arion circumscriptus with eggs
D. Arion circumscriptus showing humped position
E. Arion hortensis dorsal view
F. Arion hortensis ventral view
G. Arion subfuscus with eggs
H. Arion subfuscus showing humped position

KEY TO FIGURES 2, 4, 6, 8 AND 10

a. —atrium
s.r. —seminal receptacle
u.c. —uterine canal
a.g. —albumen gland
h.d. —hermaphroditic duct
o. —ovotestis
f.o. —free oviduct
g.p. —genital pore
e. —epiphallus
v.d. —vas deferens
p. —penis
s.d. —spermatic duct

A

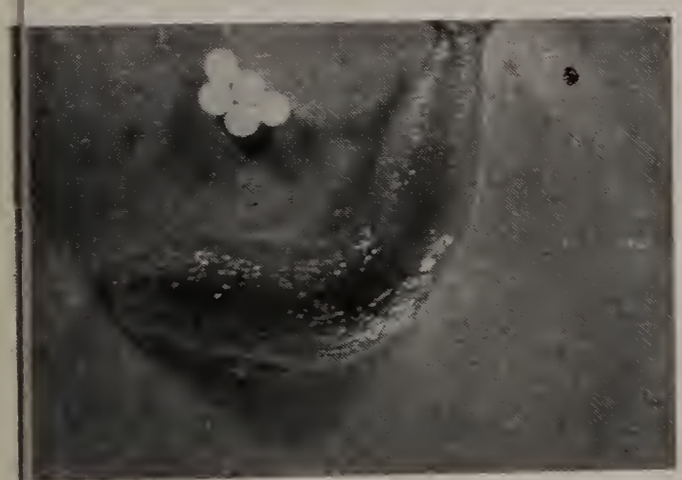
B

C

D

E

F



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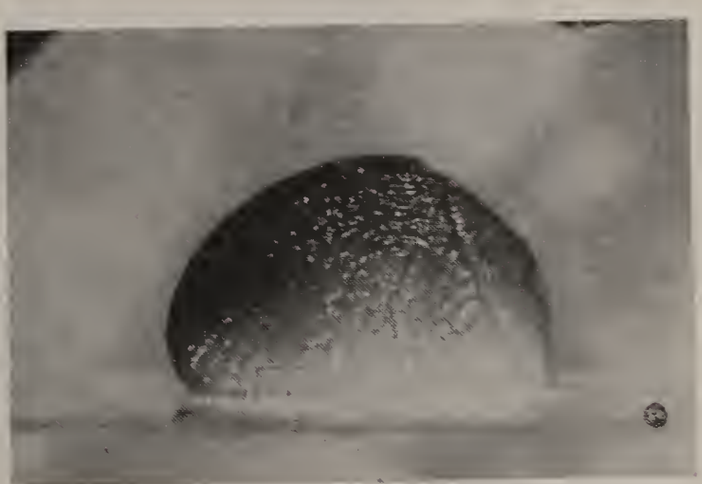

H

Plate 1

PRESIDENTIAL ADDRESS

C. C. Coffin

(Read October 18, 1948)

Members of the Institute:

In this brief review of Institute activities during the past year I must first refer to the death of Dr S. G. Ritchie, one of our oldest and most respected members. Dr. Ritchie was elected an ordinary member in 1918 and later became a life member. During 1924 to 1926 he filled the office of President. Until recently he took an active part in Institute affairs and displayed keen interest in scientific matters far beyond the bounds of his profession. It is with sincere regret that I record his passing.

I believe that as an Institute we can look back upon the past year with reasonable satisfaction. Our membership has increased by 10 ordinary, 1 associate and 18 student members. During the year the Council elected Mr. Robie Tufts to Honorary Membership on the occasion of his retirement as Migratory Bird Officer. This brings to 8 the list of our members whose services to the Institute and to science the Council has seen fit to recognize. Our total membership at present is thus made up as follows:

Honorary members	8
Life	10
Ordinary	66
Associate	50
Student	47
Corresponding	5

making a total of 186. I have not searched the records in this matter but I believe that this constitutes an all time high in membership.

During the year six ordinary meetings were held with an average attendance of 42. It is interesting to note that the average attendance in the previous year was 41. At these

meetings 13 papers on original work were presented and 2 demonstrations were given. These papers may be broken down as follows:

Biochemistry	3
Chemistry	5
Physics	2
Physiology	1
Zoology	2
	13

During the year our Library, which consists of publications received in exchange for our Proceedings, has undergone some major changes. These will be dealt with in detail in the Librarian's report. I would like, however, to take this opportunity to urge the incoming Council and the Institute as a whole to regard the Library as one of our major responsibilities. Although at present it is rather scattered a careful record should be kept of all its parts and acquisition, and every effort should be made to ensure that a clear title to them is retained. Although now it is broken up (and perhaps has its immediate usefulness enhanced thereby) it should be regarded as an entity which some day we may be able to house as such.

During the year the extensive revision of the exchange list made necessary by the war has been practically completed. The amount of work which this has entailed may be judged from the Report of the Corresponding secretary and I would like to take this opportunity to convey to him the thanks and appreciation of the Institute for the time and energy he has so generously contributed to this undertaking.

I believe that we may be reasonably well satisfied with our financial situation which will be dealt with in the Treasurer's Report.

In conclusion I should like to thank personally the Officers and other members of the Council for the generous assistance they have accorded me during my term of office.

PROCEEDINGS OF MEETINGS

SESSION OF 1948-49

(Meetings were held in the Medical Sciences Building, Dalhousie University, Halifax, N. S.)

87*th Annual Business Meeting*, October 18, 1948.

The President, Dr. C. C Coffin, presided with an attendance of 22 members. His annual address is printed in full in the proceedings. Reports of officers were presented and are summarized as follows:

Treasurer's Report:

Receipts	$2,759.91
Expenditures	2,007.65
Total assets, current account	1,397.96
Total assets, permanent fund	3,485.00

The Corresponding Secretary reported that 44 new exchanges were set up during the year and 3 were terminated, bringing the exchange list to 499 listings. In addition 121 back numbers were sent out.

The Editor reported that Part I of Volume XXII of the Proceedings was published in May, 1948. Part II of Volume XXII should go to press shortly.

The Librarian reported that 1850 publications had been received through the exchange list, and 1,178 books and papers were borrowed from the library during the year. The transfer of the Provincial Science Library including the Institute Library, from the Dept. of Mines to the Nova Scotia Research Foundation was noted.

Officers elected for the year 1948-49 were:

President	Dr. C. B. Weld
1st Vice-President	Dr. A. E. Cameron
2nd Vice-President	Dr. W. J. Chute
Treasurer	D. K. Crowdis, Esq.
Corresponding Secretary	Dr. J. G. Aldous

Recording Secretary.....Dr. W. J. Dyer
Council.....Dr. W. J. Archibald
Dr. C. C. Coffin, Dr. D. Pelluet, Dr. H. D. Smith and Dr. R. Begg.
Editor.....Dr. E. Hess
Librarian.....D. K. Crowdis, Esq.
Auditors.....Dr. R. J. Bean and Dr. H. L. Bronson.

1*st Ordinary Meeting*, November 8, 1948.

The following new members were announced (elected by Council October 28); A. M. Fraser, M.D.,C.M., J. A. McCarter, Ph.D., W. R. Trost, Ph.D., W. L. Ford, Ph.D., C. A. Reilly, M.Sc., L. Stephens-Newsham, Ph.D., ordinary members; G. W. Byrne, B.Sc., R. V. Webber, B.Sc., I. I. Tingley, B.Sc., L. C. Johnston, D. G. Smith, A. R. Reid, B.Sc., W. S. A. Singh, B.Sc., J. S. Rose, B.Sc., W. D. L. Sherren, B.Sc., F. G. Cuming, B.Sc., M. L. Cameron, A. H. Corkson, B.Sc., W. R. Bailey, B.Sc., Miss A. Melanson, B.Sc., Miss Anne H. G. Watts, B.Sc., Miss Muriel Ord, B.Sc., Miss Hope Bridgeford, B.A., Miss Shirley Mason, Miss R. W. Blount, B.Sc., Miss Alberta White, B.A., Miss Bernice Hoffman, B.Sc., Miss Marjorie Leith, B.Sc., student members.

Papers: "Exchange of Materials in a Lake as Studied by the Addition of Radioactive Phosphorus", by C. C. Coffin, F. R. Hayes, L. H. Jodrey and S. G. Whiteway; "A New Method for Measuring the Analgesic Power of Drugs in Human Subjects", by J. G. Aldous and M. G. Whillans.

2*nd Ordinary Meeting*, December 6, 1948.

The following new members were announced (elected by Council December 6); J. P. Messervy, B.E., A. Goodman, Ph.D., K. Shelstad, B.Ch.E., ordinary members; H. L.

Cameron, M.Sc., associate member; and J. D. Nickerson, B.Sc., Keith Stewart, B.Sc., student members.

Papers: "The Stimulating Action of Anesthesia on Gastric Secretion", by M. Schachter; "New Records for the Distribution of Certain Land Mollusca in Nova Scotia", by Muriel J. Ord and Anne Watts; "Faulting in the Vicinity of Halifax, Nova Scotia", by H. L. Cameron.

3rd Ordinary Meeting, January 17, 1949.

It was announced that J. D. Duerr, B.Sc., was elected student member (elected by Council, January 17).

Papers: "Heparin and Lipemia", by C. B. Weld; "A Method for Studying the Specificity of Metabolic Inhibitors in Intact Cells", by J. G. Aldous; "An Attempt to Poison Coarse Fish in a Lake While Leaving Trout Unharmed", by D. A. Livingstone.

4th Ordinary Meeting, February 14, 1949.

Announcement of the election of Miss Ruth Nicholson as student member was made (elected by Council, February14).

Papers: "The Cytology of the Reproductive Organs of Certain Land Mollusca of Nova Scotia", by Anne Watts and Muriel J. Ord; "Chemical Estimation of Reducing Steriods in the Adrenal of the Rat", by R. W. Begg; "Glacial Geology of the Yarmouth-Pubnico Area", by H. L. Cameron.

5th Ordinary Meeting, March 14, 1949.

Papers: "The Influence of Relaxation Times on Nuclear Paramagnetism", by A. T. Stewart; "The Exchange of Ag^+ Ions Between Aqueous Solutions and Surfaces of Metallic Silver", by C. C. Coffin and I. I. Tingley; "A New Method for Detecting Nuclear Magnetism", by E. W. Guptil, A. T. Stewart, and W. J. Archibald (with demonstration).

6*th Ordinary Meeting*, April 11, 1949.

Papers: "The Chemical Composition of Marine Algae", by M. G. MacPherson and E. G. Young; "Sensitization of the Gastric Gland to Histamine after Complete Vagotomy", by M. Schachter; "The Alleged Synthesis of Protein from an Inorganic Medium in the Presence of Iron", by E. G. Young and J. H. Ryan.

7*th Ordinary Meeting*, May 9, 1949.

Papers: "Some Effects of Temperature on the Embryonic Development of the Salmon (Salmo salar)", by Marjorie Smith; "The Phase Contrast Principle in Microscopy", by D. H. Rogers; "A Dynamical Model of Crystal Structure", by D. W. Wylie.

(Papers read before the Institute but not published in the proceedings.)

Exchange of Materials in a Lake as Studied by the Addition of Radioactive Phosphorus. C. C. Coffin, F. R. Hayes, L. H. Jodrey, and S. G. Whiteway, Depts. of Chemistry and Biology, Dalhousie University, Halifax, N. S. (Read November 8, 1948.) One hundred millicuries of radioactive phosphorus, P_{32} were added to the surface of an acid bog lake in Halifax County, of area 0.8 acre and depth 20 feet. The lake had a well developed zone of cold, stagnant water at the bottom with a thermocline above. Within a few hours the phosphorus was taken up strongly by the sphagnum, which made up most of the lake margin, by the floating plankton, and by sponges. Within a few days it was observed in the bodies of fishes (Fundulus and Notemigonus), and within a fortnight had accumulated in their skeletons and viscera. Uptake by bottom rooted forms such as the yellow lily (Nuphar), and marginal rooted forms such as the cranberry (Vaccinium), was by comparison extremely slow. Penetration of the added phosphorus into the lake depths was very slow, and even at the end of eight weeks the material was only doubtfully detected at the bottom. Uptake by bottom mud was correspondingly delayed.

A New Method for Measuring the Analgesic Power of Drugs in Human Subjects. J. G. Aldous and M. G. Whillians, Dept. of Pharmacology, Dalhousie University, Halifax, N. S. (Read November 8, 1948.) In view of the fact that relatively complicated procedures are needed for quantitating the pain-obtunding properties of analgesic drugs, the need has long been felt for a simpler method of obtaining this information. Although primarily designed for use in laboratory courses in Pharamacology, there is no reason why the device described can not be refined to produce a useful research tool. Pain in the form of heat, is delivered to the subject's skin by means of a stimulator which consists of a thermometer whose bulb is surrounded by a small glass water jacket The point at which the subject's sensation changes from pain to heat is read in degrees centigrade from the thermometer and is referred to as the pain threshold. The ability of certain analgsics to raise the pain threshold has been measured and the results obtained are highly significant when analyzed according to the t^2 method of Fisher.

The Stimulating Action of Anesthesia on Gastric Secretion. M. Schachter, Dept. of Physiology, Dalhousie University, Halifax, N. S. (Read December 6, 1948). Chloralose, and particularly chloralose-urethane have long been the anaesthetics of choice for the study of gastric secretion under conditions of acute experimentation. Despite their frequent use there never has been any mention in the literature of the influence of these or other forms of anaesthesia on the gastric secretory process. Our studies on dogs have shown that chloralose, and chlorase-urethane anaesthesia result in a marked secretion of very acidic gastric juice in dogs previously with gastric fistulae and not subjected to any trauma at the time of anesthesia. Urethane, pentothal and to a much lesser degree nembutal anesthesia also resulted in the secretion of vary, ing amounts of gastric juice of high acidity under similar conditions. Under chloralose or chloralose-urethane anaesthesia dogs occasionally secreted as much as 80 ccs. of highly acidic gastric juice within an hour. In general the gastric juice during active secretion contained very little

pepsin or visible mucus. In all instances this secretion was completely or almost completely arrested by subcutaneous administration of 1.5 or 2 mgm. of atrophine sulfate. The chloralose-urethane secretion was regularly found to approach a p^H. of 0.9 and to possess minimal amounts of pepsin and visible mucus. It was completely abolished by the traumatic procedure of preparing the gastric fistula at the time of the experiment and was at times completely prevented by slight mechanical manipulation of the vagi in the neck. In those instances where the phenomenon was not abolished by exposure of the crevical vagi, it was immediately arrested following acute vagal section. The secretion returned to full intensity within a few days after vagal section only to almost completely disappear again as time for nerve degeneration elapsed. The secretion as not associated with a reduced blood sugar level. In view of the histamine-like nature of the secretion possibility of histamine liveration at the vagus nerve endings is raised. Also the degree of inhibitory activity associated with trauma or manipulation of the vagus nerve suggests the possibility of an inhibitory function of the vagus nerve directly on the secretory cell.

Heparin and Lipemia. C. B. Weld, Physiology Dept., Dalhousie University, Halifax, N. S. (Read January 17, 1949). The changes (previously reported) in the optical density of lipemic plasmas following intravenous heparin are transient and are accompanied by a parallel change in chylomicron count. During lipemia before heparin is given the prevailing chylomicron particle is large and bright, while after heparin it is very minute in size, many being barely visible at 1300 diameters under dark field illumination. Actual counts show both large and small particles to be reduced in numbers by heparin. Immediately after the heparin is given there is a variable amount of clumping of chylomicrons, especially of the larger ones. The clumps disappear within a few minutes. The possibility that this is the mechanism by which heparin clears the lipemia is not probable because (a) careful histological search of many tissues has failed to reveal these clumps and (b) the lipid content of the plasm is unchanged. The heparin is effective in vivo in the intact animal; but not in vitro in plasma. It is partially effective in whole blood incubated at 37°C the number of both large and small particles being slightly reduced. A tenfold dilution of lipemic plasma reduces the count of both large and small particles one quarter. These facts indicate that the degree of dispersion of the lipid particles during lipemia is readily variable and suggest that intravenous heparin increases the dispersion. It is thought that many of the particles become so small as to become invisible even under dark field illumination.

A Methed for Studying the Specificity of Metabolic Inhibitors in Intact Cells. J. G. Aldous, Dept. of Pharmacology, Dalhousie University, Halifax, N. S. (Read January 17, 1949). The question of whether a metabolic inhibitor has any specificity associated with its action upon the enzymes in a cell has largely been obscured by the techniques used to obtain the desired information. In order to demonstrate an appreciable reduction in activity of an isolated preparation, the concentration of inhibitory agent needed is often ten, sometimes one hundred times greater than that required to suppress the same activity in the intact cell. The present method seeks to obviate this difficulty by exposing the intact cell to the action of the inhibitory agent and to pro-

ceed then to an evaluation of the various enzymic constituents of the cell. Although its field of usefulness is confined to changes brought about by irreversible inhibitors, the prodecure offers an advantage over older methods in that one is observing the action of the inhibitory agent under in vivo conditions.

An Attempt to Poison Coarse Fish in a Lake While Leaving Trout Unharmed. D. A. Livingstone, Biology Dept., Dalhousie University, Halifax, N. S. (Read January 17, 1949). Derris root dust in the proportion of one part to two million water, was added to the shallow part of Copper Lake, Nova Scotia, i.e. to the 10 foot zone. Copper Lake is known to contain trout together with an abundance of coarse fish. In August, when the lake was poisoned, the trout might be expected to be in the cool waters 20 to 30 feet down. Fish began to die shortly after poisoning, and were counted as they drifted ashore. Applying a customary factor for the ratio of fish ashore to the total fish dead it would appear that about 40,000 to 50,000 fish were killed, of which about 10 were trout.

The Cytology of the Reproductive Organs of Certain Land Mollusca of Nova Scotia. Anne H. G. Watts and Muriel J. Ord, Biology Dept., Dalhousie University, Halifax, N. S. (Read February 14, 1949). This paper deals with chromosome counts of the germ cells in the ovatestes of five species of land Mollisca of the families Arionidae and Limacidae, in addition to a description of the morphology of the sperm of each species. The information has been obtained from permanent smears of parts of the reproductive systems of these animals. Photographs of the chromosomes, and camera lucida drawings of both chromosomes and sperm are shown.

Chemical Estimation of Reducing Steroids in the adrenal of the Rat. R. W. Begg, Cancer Research Laboratory, Dept. of Biochemistry, Dalhousie University, Halifax, N. S. (Read February 14, 1949). The method of Heard and Sobel for the estimation of reducing steroids in the urine has been adapted to an adrenal extract prepared by the technique of Cartland and Kuizenga. The ultraviolet absorption curve of the adrenal extract resembles that of desoxycorticosterone acetate. The values for reducing steroids in the adrenals of normal and tumor-bearing rats follow the expected pattern of adrenal activity as compared with histochemical studies with Sudan IV and dinitrophenylhydrazine, and by chemical estimation of cholesterol and ascorbic acid.

Glacial Geology of the Yarmouth-Pubnico Area, Nova Scotia. H. L. Cameron, Geology Dept., Acadia University, Wolfville, N. S. (Read February 14, 1949). The area includes the southwest tip of Nova Scotia. Bedrock is granite and sediments of the Meguma Series which outcrop on the coast and infrequently on lakes and rivers. The entire area is mantled with glacial drift and the drainage is poor and disorganized with many swamps and barrens. A submergent coast line results in many long inlets and shallow swampy bays. The numerous islands are drowned drumlins or remnants of the drift mantle. All types are represented from well formed uneroded drumlins, to submerged reefs which are the rock bases from which all glacial material and soil have

been removed by the sea. The drumlins are of economic importance as they represent a high percentage of the arable land. Eskers are very frequent and attain lengths of several miles. Those in the Wedgeport area are described in some detail with aerial and terrestrial photographs.

THE INFLUENCE OF RELAXATION TIMES ON NUCLEAR PARAMAGNETISM. A. T. Stewart, Physics Dept., Dalhousie University, Halifax, N. S. (Read March 14, 1949.) This paper reports a study of the influence of dissolved ferromagnetic ions on the time required for the paramagnetism associated with nuclear spin (in this case, of protons in liquid water) to reach equilibrium in a magnetic field. This time is commonly called the relaxation time.

THE EXCHANGE OF Ag+ IONS BETWEEN AQUEOUS SOLUTIONS AND SURFACES OF METALLIC SILVER. C. C. Coffin and I. I. Tingley, Chemistry Dept., Dalhousie University, Halifax, N. S. (Read March 14, 1949). The exchange of Ag+ ions between solutions of silver nitrate and surfaces of metallic silver is being studied with a radioactive isotope (Ag110, half-life 225 days). On the basis of measured areas etched and polished surfaces of annealed silver foil exchange with 0.1N $AgNO_3$ solutions to depths of about 10 and 100 atomic layers respectively. Inactive crystalline (etched) surfaces pick up their maximum activity from stirred oxygen-free active (40,000 counts per minute per ml.) solutions in a matter of seconds; under the same conditions polished surfaces acquire about 90% of their final equlibirium activity in 24 hours. Polished surfaces made active in this way and immersed in nonactive solutions lose about 25% of their activity at roughly the same rate as they had acquired it. No decrease in the remaining activity occurs during a week's stirring in the non-active solution. Under similar conditions crystalline surfaces appear to retain their entire activity which, however, is so low (10-20 counts above background) that the experimental results are highly uncertain.

Etched surfaces of unannealed foil, or of annealed foil that has been cold-worked in various ways, show visually distinct patterns of crystalline and "noncrystalline" metal. The latter appears as light smooth streaks or patches on the uniformly dark grey crystalline metal. Such mixed surfaces although they may be largely crystalline pick up activities commensurate with those acquired by highly polished surfaces (100-200 counts per min. per sq. cm.) and give autoradiographs showing that this activity is largely confined to the crystalline areas. This means that crystalline silver which by itself shows little tendency to exchange with ions in solution receives a deposit of metal when it is mixed with noncrystalline silver. This must be the result of an electrolytic action in which ions enter the solution from the anodic worked areas and deposit from solution on the cathodic crystalline surface. However many attempts to increase the activity takeup of an etched annealed foil by connecting it electrically with a polished foil in the same solution have been fruitless. It would seem that the potential differences involved are so small that they are effectively short-circuited by imperfections in the polish layer.

The fact that polished surfaces slowly acquire a partially removable activity and that considerable activity is picked up by the smooth anodic areas of a mixed surface suggests that two exchange mechanisms are

involved. One, the electrochemical, accounts for the greater part of the activity acquired by the crystalline areas of a "mixed" surface. The other, kinetic in nature, is responsible for the activity taken up by polished surfaces and the anodic noncrystalline areas of cold worked specimens. The enhanced reactivity and solvent properties of metals brought about by polishing and cold working are well known and it is probable that such surfaces would take part in exchanges that are impossible for crystals. Preliminary experiments on the pretreatment of surfaces in nonactive solutions indicate that it is possible to separate these two effects.

A New Method For Detecting Nuclear Magnetism. E. W. Guptil, A. T. Stewart and W. J. Archibald, Physics Dept., Dalhousie University, Halifax, N. S. (Read March 14, 1949). The amplitude of oscillation of an oscillator is dependent upon the fractional part of its output energy which is returned to its input. This electrical coupling is ordinarily achieved by the presence of inductances in the output and input circuits which are near each other. This coupling can be altered by a change in the geometrical position or by any alteration of the magnetic properties of the material inside the coils. This latter characteristic has been successfully used to determine the frequencies at which the nucleus of the matter inside the coils undergo resonant vibrations.

The Chemical Composition of Marine Algae. M. G. MacPherson and E. G. Young, Dept. of Biochemistry, Dalhousie University, Halifax, N. S. (Read April 11, 1949). Fourteen species of the commoner marine algae of Nova Scotia have been analyzed for their content of water, nitrogen, ash, calcium, phosphorus and iron. These algae were remarkable for their consistently high ash content. The minimum value was 14.5 per cent in *Eucus serratus* and the maximum 45.4 per cent in *Enteromorpha intestinalis.* The average content was 24.9 per cent. Differences in composition have been observed between the green, red and brown classes of algae.

Sensitization of the Gastric Glands to Histamine After Complete Vagotomy. M. Schachter, Dept. of Physiology, Dalhousie University, Halifax, N. S. (Read April 11, 1949). Complete cervical vagotomy was performed on 6 dogs whose gastric secretory response to histamine had been determined previously. Three dogs died after vagotomy before their gastric secretory responses to histamine could be determined. Of the 3 surviving animals one is still alive 4 months after vagotomy, another was sacrificed after 11 weeks and a third survived 26 days. The 3 surviving animals showed a persistent sensitization of the gastric response to histamine and the total acid secreted after vagotomy increased by 315%, 210% and 55% in each animal respectively. These findings are in accord with Cannon's law of sensitization after denervation but are at variance with Dragstedt's conclusion that the response of the gastric glands to histamine is materially decreased by vagotomy.

The Alleged Synthesis of Protein From an Inorganic Medium in the Presence of Iron. E. G. Young and J. A. Ryan, Dept. of Biochemistry, Dalhousie University, Halifax, N. S. (Read April 11, 1949). Attempts have been made to repeat the work of Francis in which it was claimed that miscropic particles of protein were synthesized from Liescke's medium in the presence of iron. The appearance of particles which were

colored by microchemical tests for protein was confirmed under these conditions. They are interpreted as artifacts due to the fortuitous occurrence of glass films or other particles in the preparations. The suitability of the different microchemical tests for protein has been examined critically and shown to be susceptible to fallacious results.

Some Effects of Temperature on the Embryonic Development of the Salmon (salmon salar). Marjorie Smith, Biology Dept., Dalhousie University, Halifax, N. S. (Read May 9, 1949). During the years 1947, '48, and '49, experiments were carried out to observe the effects of temperature, which were within the survival limit, on the development of salmon embryos. The investigation involved attempts to determine whether the order of appearance of morphological features could be altered by the use of different developmental temperatures. Observations and recordings were made of the times when different morphological features made their appearance. It became evident from the beginning that certain morphological features, such as pigment in the eyes, and bile in the lumen of the gut, made their appearance in eggs at 14°C on the same day. However by the time these two features appeared in eggs at cold temperatures, the presence of pigment in the eyes had overtaken the presence of bile in the gut. This is one of the cases of dissociation which was observed and investigated. From the studies made, dislocations in the order of differentiation are possible with a change in temperature at which development takes place.

The Phase Contrast Principle in Microscopy. D. H. Rogers, Physics Dept., Dalhousie University, Halifax, N. S. (Read May 9, 1949). The phase contrast microscope has been applied to the study of pleochrioc haloes, the interpretation of the image is discussed.

A Dynamical Model of Crystal Structure. D. W. Wylie, Physics Dept., Dalhousie University, Halifax, N. S. (Read May 9, 1949). An array of atoms is simulated by an assemblage of bubbles floating on the surface of a solution composed of sugar dissolved in Aerosol. The bubbles were blown from a fine jet beneath the surface of the solution which was held in a rotation tray at a slight angle to the horizontal. All experiments were performed on a two dimensional raft held together by surface tension. The various properties of crystal structure as, grain boundaries, dislocations, slippage planes and the processes of recrystallization and annealing were demonstrated. Also compressional forces were applied to the raft in an attempt to measure Poisson's Ratio.

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PROCEEDINGS

OF THE

Nova Scotian Institute of Science

HALIFAX, NOVA SCOTIA

VOL. XXII. 1949-1950 PART 4

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CONTENTS

Hymenoptera and an Inquiline Moth Reared from the Goldenrod Galls Caused by *Gnorimoschema Gallaesolidaginis* Riley, (Lepidoptera W. W.) Judd 1

Spongilla Nova Terrae Potts; A Fresh Water Sponge New To Nova Scotia. Muriel J. Ord and Anne H. G. Watts 8

A New Record for the Mastodon, *Mastodon Americanus* Kerr, from Nova Scota. Daniel Livingstone 15

An Increasing Atlantic Influence in Hudson Bay. W. T. Bailey and H. B. Hachey 17

The Vertical Temperature Structure of the Labrador Current. W. B. Bailey and H. B. Hachey 34

Presidential Address. C. B. Weld 49

Proceedings of Meetings. Session of 1949-50 54

Abstracts. (Papers read before the Institute but not published in the Proceedings) 58

Editor: H. Ritchie Chipman

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ERRATA

With reference to front cover and "Contents, 1949-50"

"Anne H. G. Watts" should read "M. L. Cameron"

"W. T. Bailey" should read "W. B. Bailey"

PROCEEDINGS

OF THE

Nova Scotia Institute of Science

SESSION OF 1949-50
Vol. XXII, Part 4

HYMENOPTERA AND AN INQUILINE MOTH REARED FROM THE GOLDENROD GALL CAUSED BY *Gnorimoschema gallaesolidaginis* RILEY (LEPIDOPTERA)

W. W. Judd

Department of Zoology, McMaster University
Hamilton, Ontario

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(Received for publication 9th February, 1950)

Abstract

From 98 goldenrod galls caused by *Gnorimoschema gallaesolidaginis* Riley, collected on Jan. 8, 1949 at Hamilton, Ontario, there emerged one adult of the moth *Epiblema scudderiana* Clemens, two ichneumonid wasps, *Calliephialtes notandus* (Cress.), two other ichneumonid wasps, *Glypta caulicola* Cush., 348 (33.9% male, 66.1% female) braconid wasps, *Apanteles cacoeciae* Riley and 229 perilampid wasps, *Perilampus fulvicornis* Ashm. *P. fulvicornis* was probably a hyperparasite emerging from larvae of *Apanteles cacoeciae*.

MATERIALS AND METHODS

On January 8, 1949, 558 galls caused by *Gnorimoschema gallaesolidaginis* Riley were removed from stems of goldenrod, *Solidago* sp., in fields adjacent to the campus of McMaster University, Hamilton, Ontario. The dead stems of the goldenrod stood upright in the fields and a gall was removed by breaking a stem a few inches above and below the gall. On January 9, 39 of the galls were split lengthwise with a scalpel and their contents were examined. One gall contained a white pupa of an ichneumonid wasp and each of the other 38

contained a yellow caterpillar. The caterpillars wriggled sluggishly when disturbed and some crawled slowly about when removed from the gall. The remaining 519 galls were placed in numbered shell vials in order that insects emerging from them might be collected and examined. Each gall was placed in a vial of dimensions 95 mm. x 25 mm. and the vial was closed firmly with a wad of cotton. The vials were placed in cardboard trays and were kept at room temperature. They were examined daily and insects which emerged from the galls were removed from the vials and were preserved in fluid or pinned. On May 6, 1949 all the galls were removed from the vials and were discarded.

RESULTS

During the period January 17 to March 27 a single moth and 581 hymenopterous parasites emerged from 98 of the galls. The remaining 420 galls produced no insects. In most cases the parasites emerged from the galls directly but in a few instances the appearance of the parasites was preceded by the emergence of the lepidopterous larva. In such a case the larva moved about in the vial for a few hours and then became quiescent. The parasitic larvae emerged from the caterpillar, leaving only a shrivelled skin, and spun cocoons on the glass of the vial adjacent to the dead larva. The names of the insects which emerged from the galls and the numbers of each species that emerged are summarized in Table 1. The only moth that appeared was an adult of *Epiblema scudderiana* Clemens. The parasitic wasps represented in the collection were as follows: *Calliephialtes notandus* (Cress.) and *Glypta caulicola* Cush. (Ichneumonidae), both determined by Mr. B. D. Burks of the U. S. National Museum, *Apanteles cacoeciae* Riley (Braconidae), determined by Mr. C. F. W. Muesebeck of the U. S. National Museum and *Perilampus fulvicornis* Ashm. (Perilampidae) determined by Mr. A. B. Gahan of the U. S. National Museum.

LEPIDOPTERA

Olethreutidae

Epiblema scudderiana Clemens

A single moth of this species emerged from a gall on March 7. The typical fusiform shape of the gall was modified by a secondary swelling at its upper end. From a hole in this swelling the empty pupal skin projected obliquely upward,

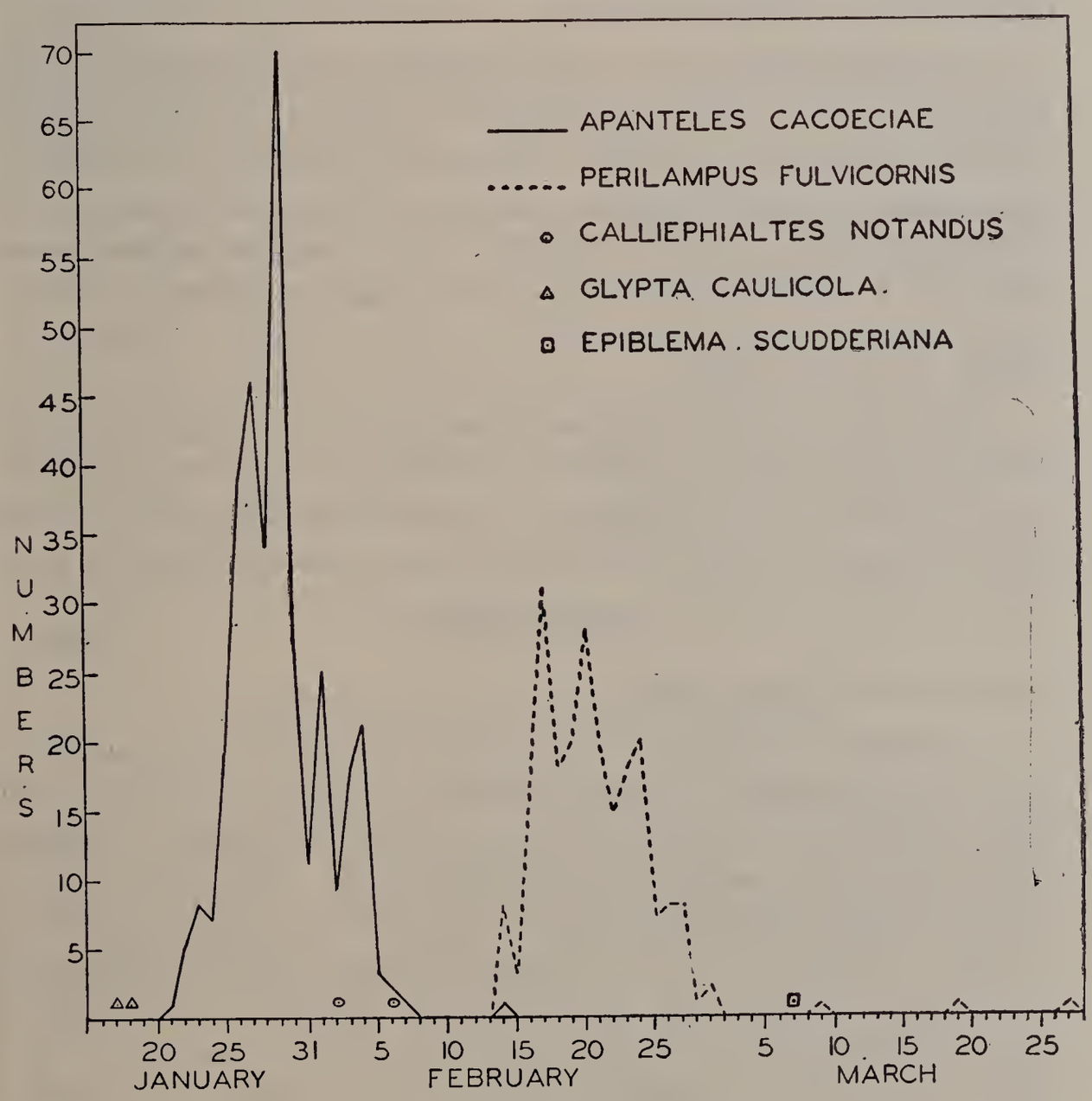

Figure 1

Periods of emergence of insects reared from galls.

only its lower end being still within the hole. The position of the pupal skin was similar to that figured by Holland (1916)

who discussed this species under the name *Eucosma scudderiana* Clemens, giving it the common name "The Misnamed Gall-moth" and pointing out that it is probably an inquiline in the spindle gall of goldenrod.

HYMENOPTERA

Ichneumonidae

Calliephialtes notandus (Cress.)

Two females of this species emerged from two galls, one on February 2, the other on February 6 (Fig. 1). Leiby (1922) records this species as being a common parasite in the goldenrod gall in North Carolina and present also at Ithaca, New York, and Barber (1938) reports that it accounted for parasitism of 4.83% of the galls studied by him in Virginia.

Glypta caulicola Cush.

Two males of this species emerged from two galls, one on January 17, the other on January 18 (Fig. 1). Cushman, (1933) in giving this insect the name *G. caulicola*, recorded that it was reared from the gall of *Gnorimoschema gallaesolidaginis.*

Braconidae

Apanteles cacoeciae Riley

A total of 348 wasps of this species emerged from the galls. The first emergence of males occurred on January 21, and the last on February 14; the first emergence of females occurred on January 22, and the last on February 7. Maximum emergence of males (25) and females (45) occurred on the same day, January 29 (Fig. 1). Of the total number, 118 (33.9%) were males and 230 (66.1%) were females, giving a ratio closely approximating 1: 2. These wasps emerged from 74 of the galls. As noted in Table 2 the maximum number of adults produced from a single gall was 18 and the minimum number was one. Possibly more than 18 actually emerged from a single caterpillar but failed to leave the gall.

Perilampidae

Perilampus fulvicornis Ashm.

A total of 229 adults emerged from the galls. The first appeared on February 14, the last on March 27, and the maximum emergence occurred on February 20 (Fig. 1). Smulyan (1936) states that the species of *Perilampus* appear to be largely hyperparasitic, and records that *P. fulvicornis* has been reared from *Apanteles* sp. He points out that this species has been reared in association with a number of lepidopterous insects, but that very likely it was hyperparasitic.

The specimens of *P. fulvicornis* reared from the galls were very probably parasites of *Apanteles cacoeciae*. They began to emerge on February 14, the day when the last *A. cacoeciae* appeared, and they reached a maximum emergence about three weeks after the day of maximum emergence of *A. cacoeciae*. Of the 98 galls that produced parasites 62 produced both *A. cacoeciae* and *P. fulvicornis*. In instances where large numbers of *A. cacoeciae* emerged from a single gall, e.g. 11 or more, only a few *P. fulvicornis* or none at all emerged; when several *P. fulvicornis*, e.g. 9, emerged from a gall no *A. cacoeciae* appeared.

DISPOSITION OF SPECIMENS

A few specimens of *Calliephialtes notandus* (Cress.), *Glypta caulicola* Cush., *Perilampus fulvicornis* Ashm. and *Apanteles cacoeciae* Riley are deposited in the collections of the U. S. National Museum. All others are retained in collections at McMaster University.

Table I

Insects reared from galls

Date		Apanteles cacoeciae			Perilampus fulvicornis	Calliephialtes notandus	Glypta caulicola	Epiblema scudderiana
		Males	Females	Total				
Jan.	17						1	
	18						1	
	21	1		1				
	22	2	3	5				
	23	4	4	8				
	24	5	2	7				
	25	6	13	19				
	26	17	22	39				
	27	9	37	46				
	28	10	24	34				
	29	25	45	70				
	30	7	21	28				
	31	3	8	11				
Feb.	1	9	16	25				
	2	4	5	9		1		
	3	11	7	18				
	4	2	19	21				
	5	1	2	3				
	6	1	1	2		1		
	7		1	1				
	14	1		1	8			
	15				3			
	16				19			
	17				31			
	18				18			
	19				20			
	20				28			
	21				20			
	22				15			
	23				18			
	24				20			
	25				7			
	26				8			
	27				8			
	28				1			
Mar.	1				2			
	7							1
	9				1			
	19				1			
	27				1			
Totals		118	230	348	229	2	2	1

Table II

Distribution of Galls With Respect to Number of Parasites Produced

Number of parasites from a gall.....	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Number of galls from which *A. cacoeciae* emerged	7	17	10	11	8	3	9	2	1	0	1	1	1	1	1	0	0	1
Number of galls from which *P. fulvicornis* emerged.....	20	11	23	12	6	3	2	0	1	0	0	0	0	0	0	0	0	0

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Spongilla nova terrae POTTS; A FRESH WATER SPONGE NEW TO NOVA SCOTIA

MURIEL J. ORD AND M. L. CAMERON

(Received for Publication 26th July, 1950)

Abstract

Several colonies of *Spongilla novae terrae* Potts were collected on July 30, 1949, at Bluff Lake, Halifax County, and later at Eagle Lake, Halifax County. These are the first collections of this species since the original collections in Newfoundland in 1885. Figures are given to illustrate differences in spiculation between the new collections and the original, as well as between the Bluff and Eagle collections. The taxonomic position of the sponge is discussed.

While carrying out routine collections on Bluff Lake on July 30, 1949, we found a small sponge in about 3 feet of water on a rocky bottom. Fortunately gemmules had already formed so that identification was possible. Samples of the sponge were sent to Dr. Minna E. Jewell and Prof. Edward Kintner who both confirmed our identification of the sponge as *Spongilla novae terrae* Potts. On later trips the sponge was found to be very plentiful in other parts of the lake. It was also found by Ord in Eagle Lake later in the year. These are the only collections of this sponge for Nova Scotia. Both lakes are in Halifax County in the vicinity of Halifax.

Spongilla novae terrae encrusts rocks at a depth of 2 to 4 feet in clear water. The tissue of the sponge is loose rather than firm and the gemmules are unusually large, being easily distinguished by the naked eye in the fresh sponge. It is peculiar in the genus *Spongilla* because of the form of its dermal spicules which are birotulate (Figure 1). Indeed, *Ephydatia everetti* is the only other American Freshwater sponge we know of which has dermal birotulates. Its gemmule spicules are also of interest because of the crowding of spines to the two ends of the spicule, giving a somewhat birotulate appearance to the majority of gemmule spicules. Other species of *Spongilla* have smooth acerate gemmule spicules or acerates spined to nearly the same extent over their whole length.

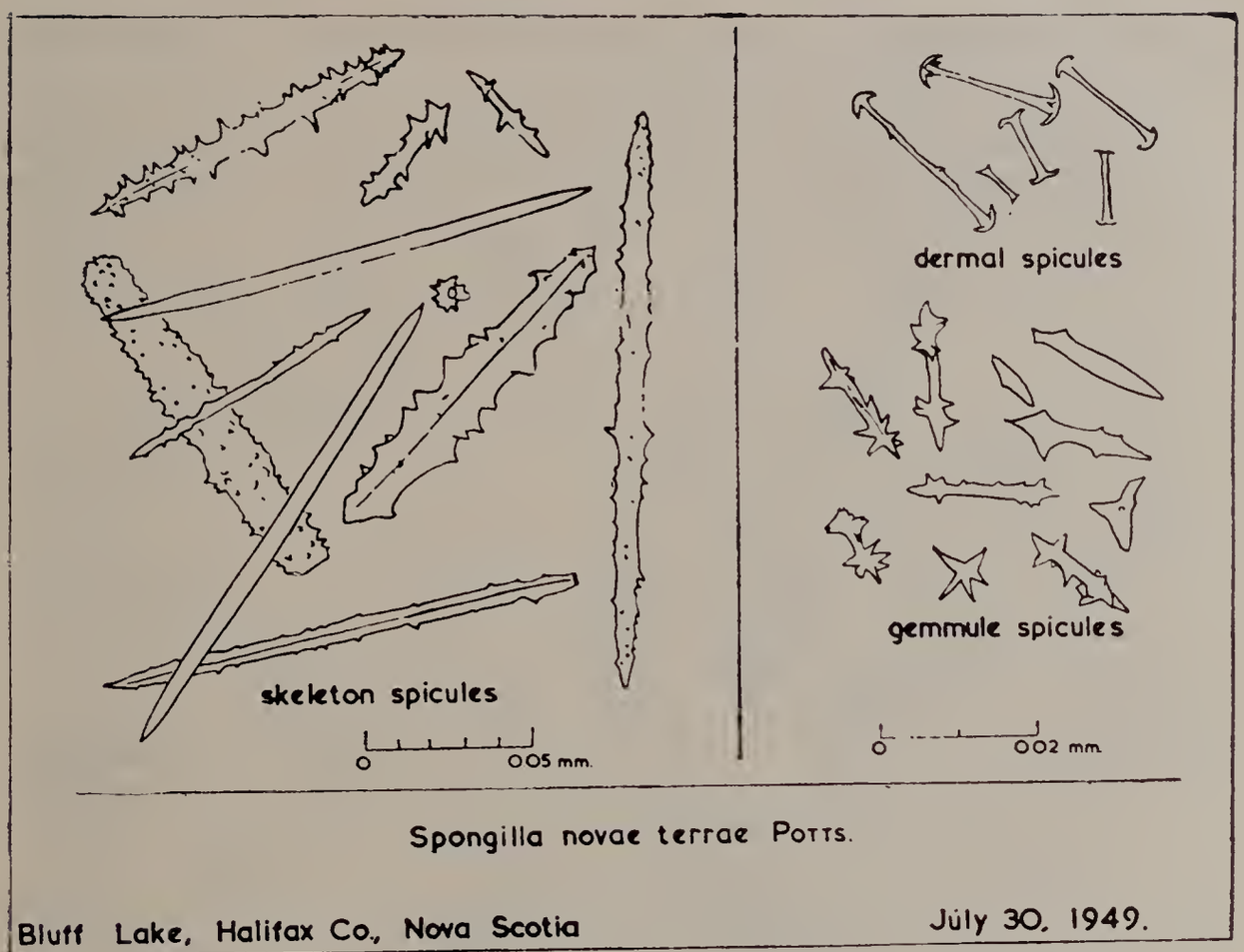

Figure 1

It is not surprising to find a species of freshwater sponge new to Nova Scotia. The only reported collections are those made by A. H. MacKay between 1884 and 1900. MacKay (1884) reported on 4 species of sponge found by him during the summer of 1883 in lakes on the Pictou-Colchester border. In 1885 he was able to report the discovery of 9 species of sponge for Nova Scotia, collected mostly in Pictou and Halifax Counties. In 1900 he named a new sponge *Heteromeyenia macouni*, collected by John Macoun in the pond on Sable Island. Since then no collections have been reported from Nova Scotia.

In 1885 MacKay was able to do some collecting in the region of Trinity Bay, Newfoundland, where he found 7 species, 6 of them already found by him in Nova Scotia, and the seventh one a new species, *Spongilla novae terrae.* This was without doubt the most interesting of his discoveries

among the sponges, and it has given us much satisfaction to have found it in Nova Scotia.

MacKay sent samples of Spongilla novae terrae to Potts of Philadelphia and to Carter of England, recognized au-

Spongilla novae terrae Potts.
HEART'S CONTENT, NFLD.
redrawn from
Potts, Ed., Fresh Water Sponges, a Monograph, Philadelphia, 1887 page 207.

Figure 2

Reproduced with permission from The Academy of Natural Sciences of Philadelphia.

thorities on the classification of fresh-water sponges. After some hesitation they assigned it to the genus *Spongilla*, although both agreed that it bore a strong resemblance to

Ephydatia. Potts noted the resemblance between the gemmule spicules of *S. novae terrae* and *E. fluviatilis* var. *acuminata*, and said, "while their form and position probably more closely associates them with the genus *Spongilla*, in which I have, after considerable hesitation, placed the species, the grouping of the ray-like spines is forcibly suggestive of

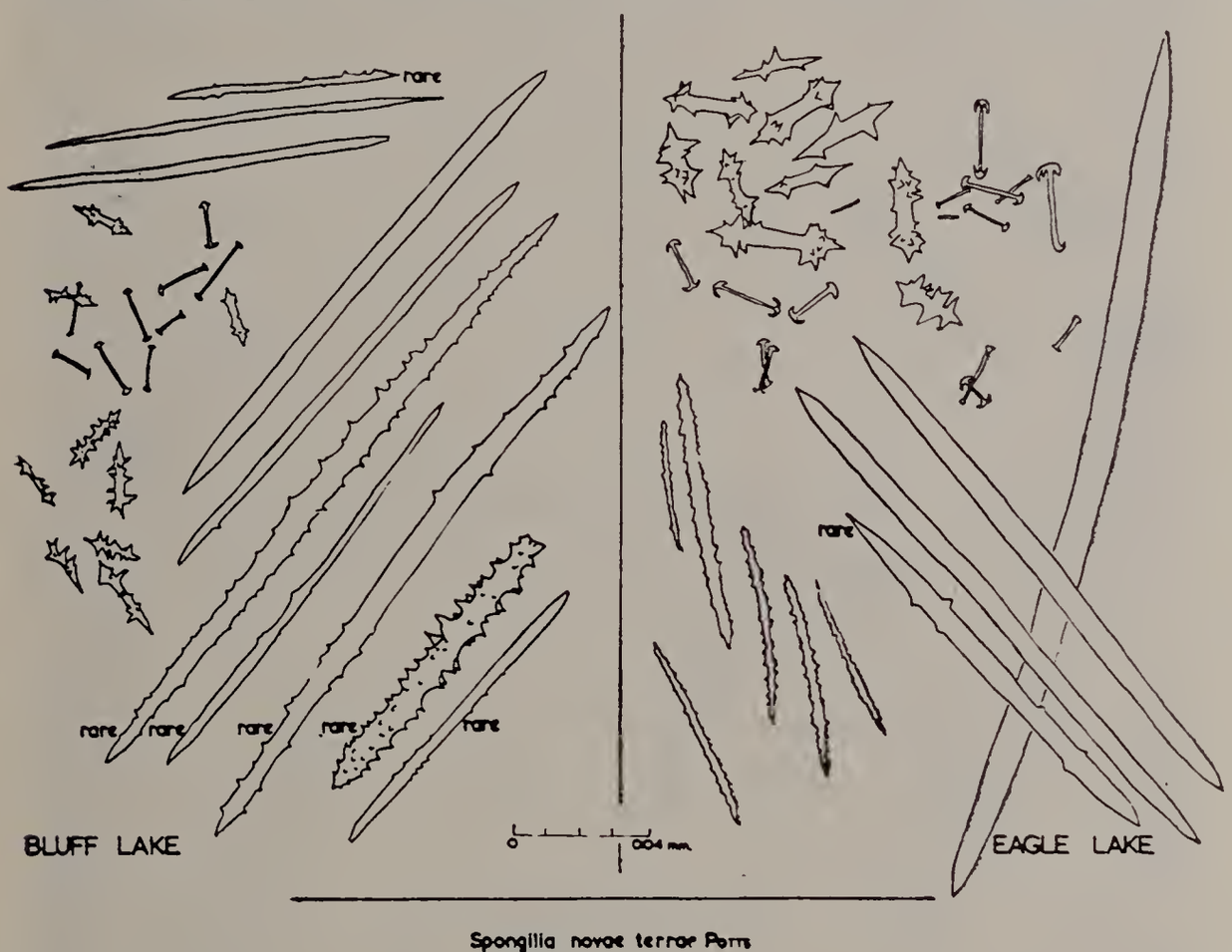

Figure 3

Meyenia (now *Ephydatia*); it will be therefore no cause for surprise, if further examination shall cause its transfer to the sister genus." This was in 1886. When he wrote his last classification of the sponges in 1918 he left it in *Spongilla*, but he added that it was "placed by some in genus *Ephydatia*." A comparison of Potts' figure of the original (Figure 2) with our sponge (Figure. 1) shows how closely they agree in appearance.

It should not be forgotten that the fresh-water sponges are classified generically according to the spiculation of the

Figure 4

Reproduced with permission from The National Museum of Natural History of Budapest.

gemmules; all genera except *Spongilla* have a more or less birotulate type of spicule. Examination of Figure 3 will show why so much doubt arose as to the proper place of *S. nova terrae.* Our first encounter with Eagle Lake specimens cost us some time trying to assign it to a species of *Heteromeyenia.* It was only careful comparison with the Bluff Lake specimens, already identified, that led us to put it in *Spongilla.*

Wierzejski reported the discovery of a sponge in Gallacia closely resembling *S. novae terrae* and placed both species in *Ephydatia.* Traxler of Hungary obtained from MacKay a piece of the Newfoundland specimen and after careful study concluded that it was a cross between *Spongilla lacustris* and *Heteromeyenia ryderi* (Figure 4).

Jewell (1935) has shown that the environment has profound effects on the appearance of the spicules, causing normal variations so great as to "abrogate accepted generic criteria." On this account we feel that an attempt should be made to extend the range of the sponge as much as possible, and, if the birotulate form can be found to be maintained or accentuated in other environments, definite steps can be taken to make a further attempt at fixing the genus.

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A NEW RECORD FOR THE MASTODON *Mastodon americanus* KERR, FROM NOVA SCOTIA

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Nova Scotia Museum of Science.

(Received for Publication 6th September, 1950)

The existing information concerning mastodon remains in Nova Scotia was brought together by the late Mr. Harry Piers in 1912, (2). Briefly, the only remains known at that time were a femur of one animal and a molar tooth, probably a second molar, of another. Both these specimens came from the island of Cape Breton, and although he heard tales of large bones lying at considerable distances from the sea in other parts of the province, Mr. Piers was unable to obtain actual mastodon specimens from the mainland of Nova Scotia.

During the late fall of 1948, Mr. Bernie MacDonald of Halifax, while working in the Naval Magazine at Burnside, Halifax County, found a large tooth in some glacial till being used to construct roads and embankments inside the Magazine area.

This tooth was examined by the author within a few days of its discovery, and identified, with the help of Osborn's monograph on the Proboscidea, (1), as a third lower molar of the right side of *Mastodon americanus* Kerr. The tooth was very kindly re-examined and its identity verified by Dr. L. S. Russell of the Royal Ontario Museum of Palaeontology.

A careful search of the magazine area by a number of persons, including the author, disclosed only a small piece which had been broken off the original tooth.

It was not possible to discover from what gravel pit the tooth had originally come, since the till in which it was found had been obtained from a number of pits around Nine-mile River near Elmsdale, Hants County, Nova Scotia. Superficial

examination of several of these pits failed to disclose any more mastodon remains.

This tooth, which is believed to be the first definite trace of the American Mastodon from the Nova Scotian mainland, is now housed in the Nova Scotia Museum of Science at Halifax, together with the molar and femur from Cape Breton Island.

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AN INCREASING ATLANTIC INFLUENCE IN HUDSON BAY

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(Received for publication 8th September, 1950)

Abstract

A comparison of oceanographic observations in Hudson Bay and Hudson Strait, made during the "Northern Cruise" of H. M. C. Ships in September 1948, with those made during the Hudson Bay Fisheries Expedition in 1930 indicates that the waters of Hudson Bay are not dynamically dead, and that the increased temperatures and salinities of the main water mass are due to an increased Atlantic influence.

INTRODUCTION

The waters of Hudson Bay and Hudson Strait are comparatively well known, and, while considerable attention has been given to this area over the past quarter century from the navigational point of view, little serious study has been given to the many and varied oceanographic problems of the area.

The first known attempt to determine oceanographic conditions in the Hudson Bay region was made by Beauchemin in 1929 (Andersen 1931), while the first detailed examination was made by one of the authors (Hachey, 1931) while officer in charge of the Hudson Bay Fisheries Expedition in 1930. The northern cruise of R. C. N. ships in 1948 provided an opportunity of making limited but detailed oceanographic observations which, when compared with those made in 1930, allow for some interesting deductions on the increasing Atlantic influence in these areas.

The general geography of Hudson Bay and Strait

Hudson Bay, connected to the Arctic by Foxe Channel, and to the Atlantic by Hudson Strait, is a shallow flooding of

the Great Continental Shelf surrounding the North Polar Sea (Canada Year Book, 1947, p. 9). Constituting an inland sea, about 250,000 square miles in area, into which is poured the drainage water from 1,500,000 square miles of continent, Hudson Bay has the character of an enormous estuarial basin. While soundings are too few to give a complete picture of the submarine physiography, the average depth of Hudson Bay is about 70 fathoms (128 metres). The greatest charted depth of 141 fathoms (258 m.) is found in the centre of the bay and a deep water channel extends from this central depression to the greater depths of Hudson Strait.

Figure 1. Hudson Bay and Strait showing the locations of "Haida" stations and positions of bathythermograph observations. September, 1948, and "Loubyrne" stations in 1930.

Hudson Strait, 430 miles in length, connects Hudson Bay with the Atlantic Ocean. The width of the strait varies from 37 miles at the entrance to 120 miles near its western extremity, and the greatest charted depth is 481 fathoms (874 m.). The high bold and broken coasts, the extremely irregular sea-floor, and the swift tidal currents combine to present what must be a mixing area of considerable extent, and must have an important role in determining the oceanographical features of the area.

The "Haida" observations 1948.

On the northern cruise of R. C. N. ships in 1948, the opportunity was provided of occupying a limited number of hydrographic stations from H. M. C. S. "Haida." Eight stations were occupied in Hudson Strait, five in early September

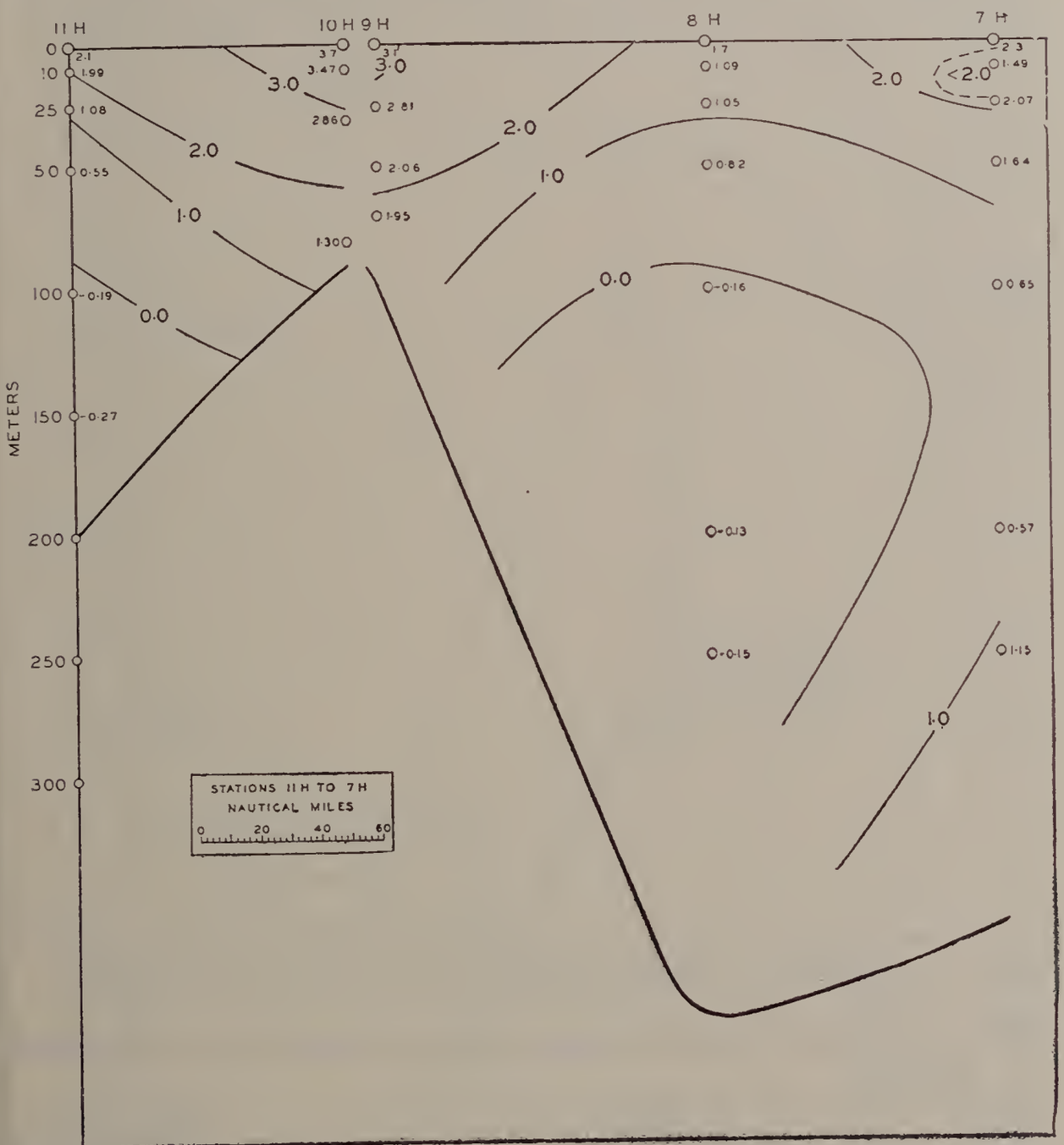

Figure 2. Temperatures in section in Hudson Strait September 6-9, 1948.

and three in late September, while six stations were occupied in Hudson Bay. The locations of all stations are shown in Figure 1. In addition, the detailed vertical temperature dis-

tribution was obtained at 50 mile intervals from bathythermograms (Spilhaus, 1938).

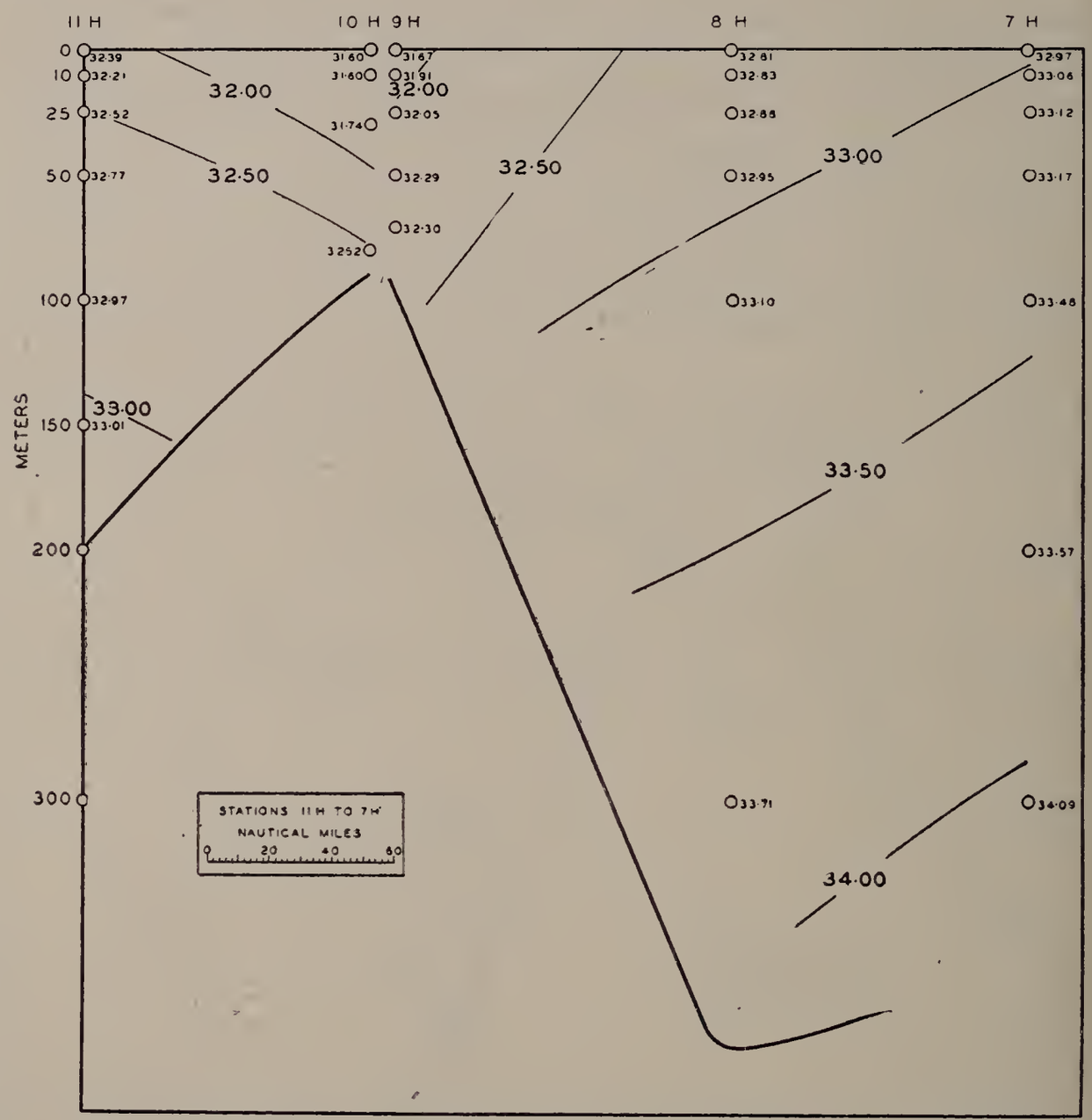

Figure 3. Salinities in section in Hudson Strait September 6-9, 1948.

The distribution of temperature and salinity in Hudson Strait

In early September the temperatures and salinities in section show Hudson Strait to be an area of intense water movements as indicated by the slope of the isotherms and isohalines in Figures 2 and 3. The main body of water in Hudson Strait, lying below the isotherm of 1.0° C., has salin-

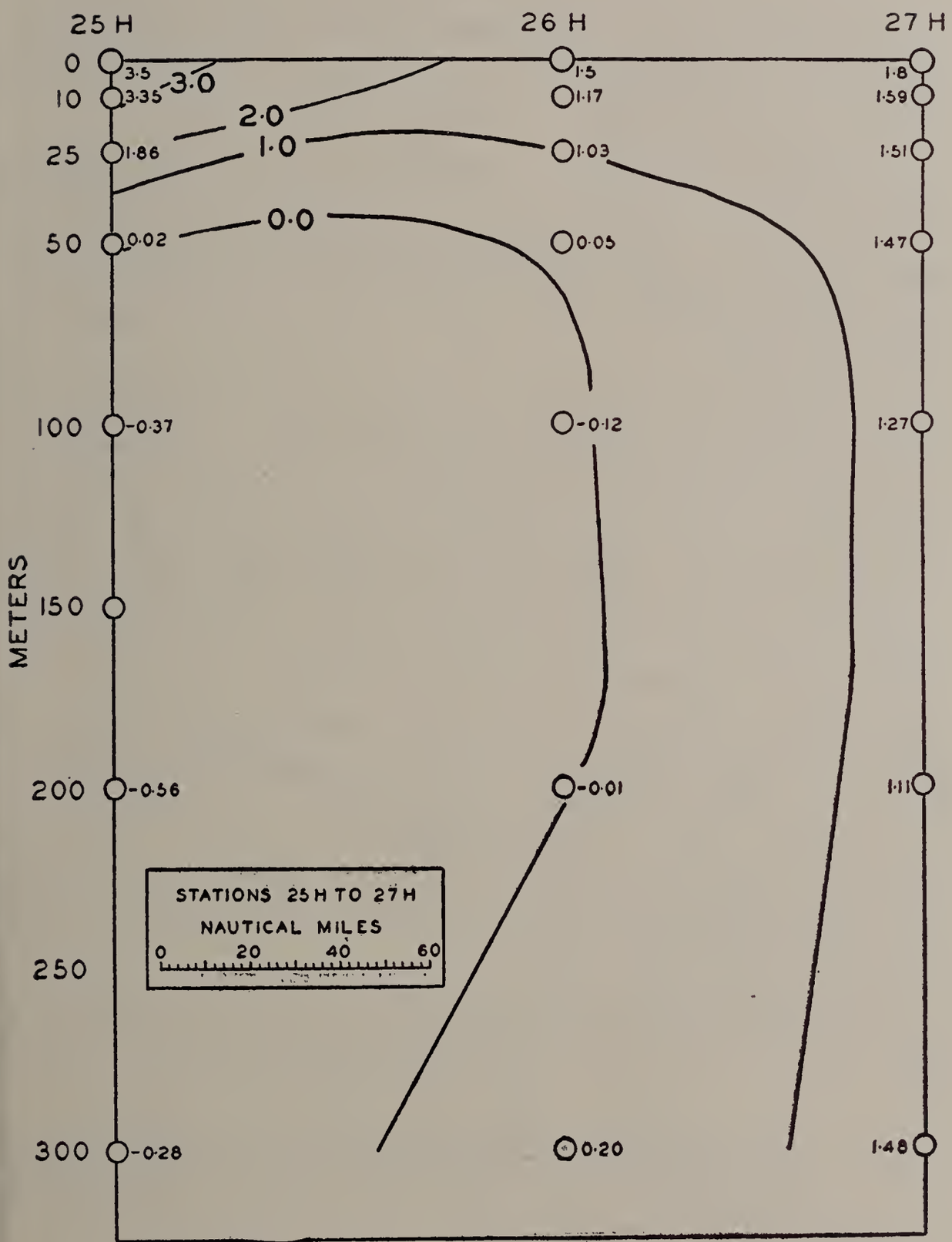

Figure 4. Temperatures in section in Hudson Strait September 20-23, 1948.

ities greater than 32.50 °/₀₀, and generally less than 34.00 °/₀₀. A large body of warm light surface water is pressed against the south side of Hudson Strait as indicated by the slope of the isotherms and isohalines at stations 9H and 10H.

Surface warming to a temperature greater than 3.0° C. is indicated by the slope of the 2.0° C. isotherm on both sides of Hudson Strait. The water in the centre has a temperature of approximately 2.0° C. In early September the surface waters are generally of temperatures greater than 3.5 and of salinities less than 32.00 °/₀₀.

Temperature and salinity sections taken in Hudson Strait in late September are shown in Figures 4 and 5. Comparatively strong temperature stratification of the upper 50 metres of water is located in the vicinity of station 25H, while strong vertical mixing is indicated by the downward slope of the isotherms between stations 26H and 27H. The warmest and coldest waters are found in the vicinity of station 25H, with temperatures ranging from 3.5° C. to -0.6° C.

Further evidence of the great mixing taking place in Hudson Strait is afforded by the salinity distribution shown in Figure 5, which indicates a certain amount of homogeneity in the water mass. Salinities range from 32.50 °/₀₀ at the surface to 34.00 °/₀₀ at 300 metres. The main portion of the water below 50 metres has temperatures less than 0.0° C. and salinities greater than 33.00 °/₀₀.

The main features of the waters of Hudson Strait, shown particularly by the late September sections (Figures 4 and 5) are:

(a) the decreasing stratification both as to temperature and salinity in the upper fifty metres from west to east;

(b) the vertical mixing as shown by the comparative uniformity of temperatures and salinities in the eastern portion of the strait; and

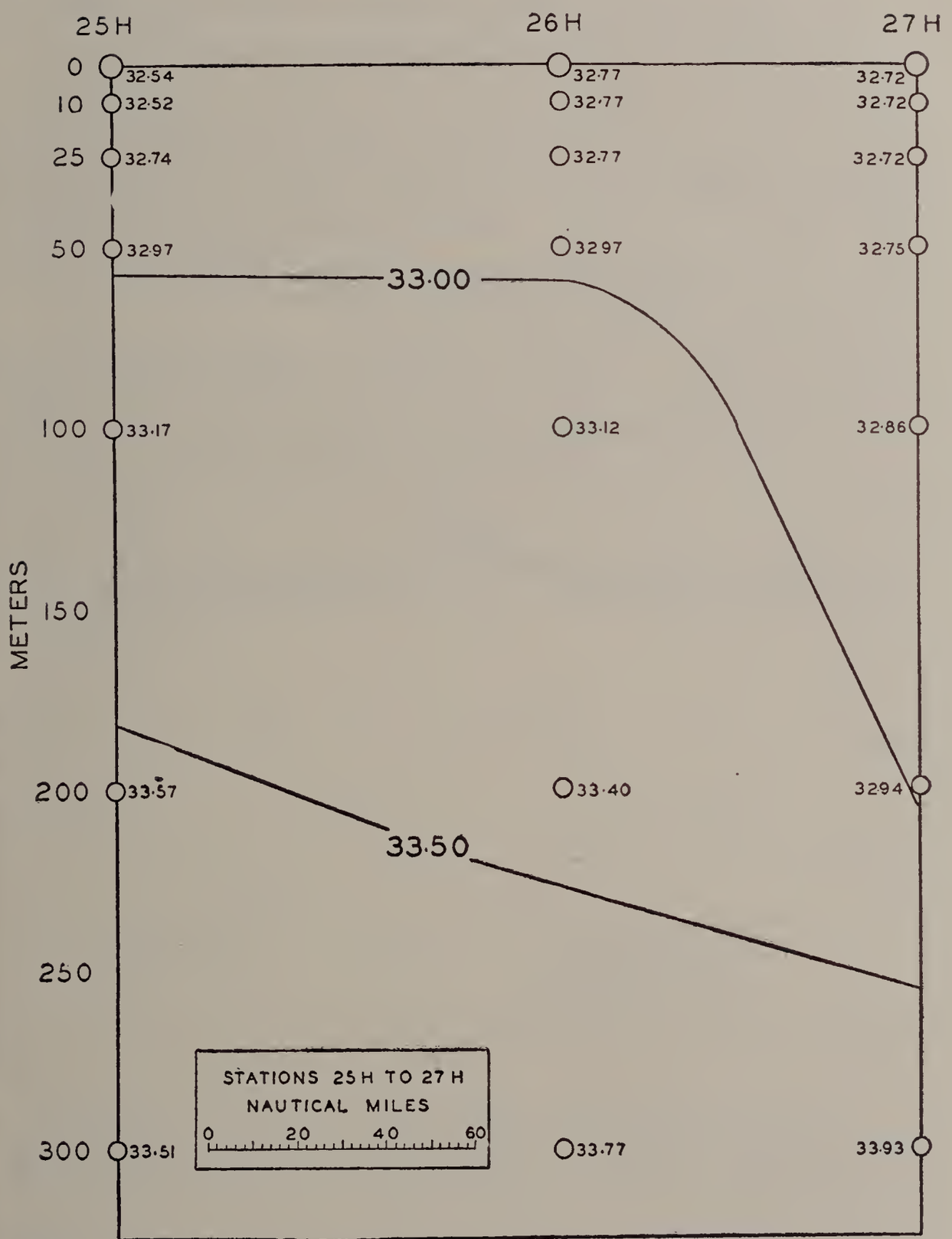

Figure 5. Salinities in section in Hudson Strait September 20-23, 1948.

(c) the increasing temperatures of the main body of water below fifty metres from west to east.

Temperature observations made with a bathythermograph at seven stations within the strait give detailed vertical temperature distribution as shown in Figure 6. Station B47 would seem to mark the transition area, where the stratification in the upper fifty metres changes over to the more mixed columns found at B48 and B49.

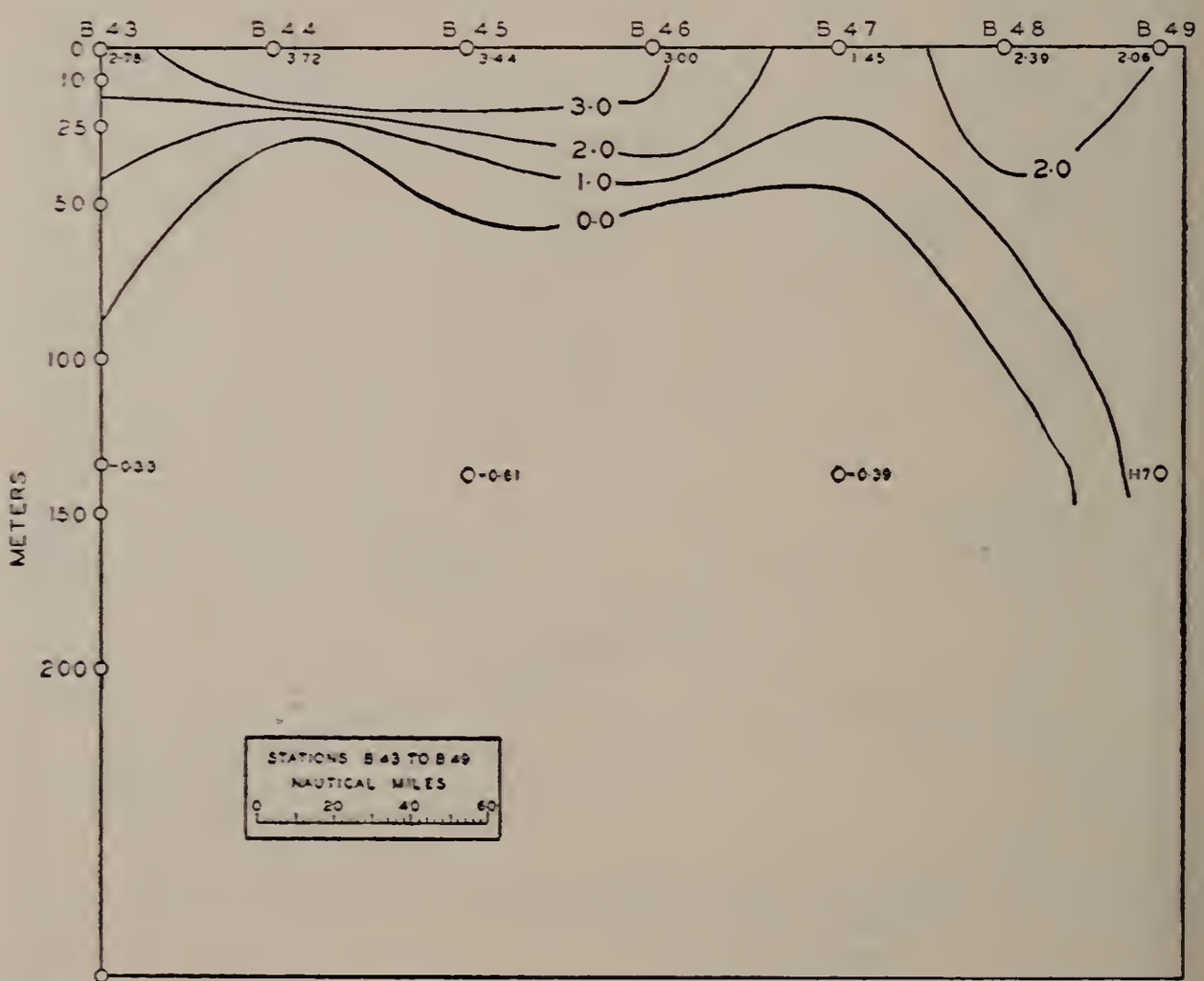

Figure 6. Vertical temperature structure in Hudson Strait September, 1948.

Distribution of temperature and salinity in Hudson Bay

Temperatures and salinities in September 1948 are plotted in a section running southwest from Hudson Strait to Churchill in Figures 7 and 8.

The main features of the waters in Hudson Bay are:

(a) the marked stratification of the upper 50 metres;

(b) the main body of cold water below 50 metres with temperatures less than -1.0° C.,

(c) the isothermal nature of the surface layers to depths of 10 to 25 metres;

(d) the low salinities in the surface layers.

The main body of water in Hudson Bay has temperatures less than -1.0° C. and salinities greater than 32.50 °/₀₀. The lowest temperature of -1.6° C. and a high salinity of 33.50 °/₀₀ are found in the vicinity of station 15H.

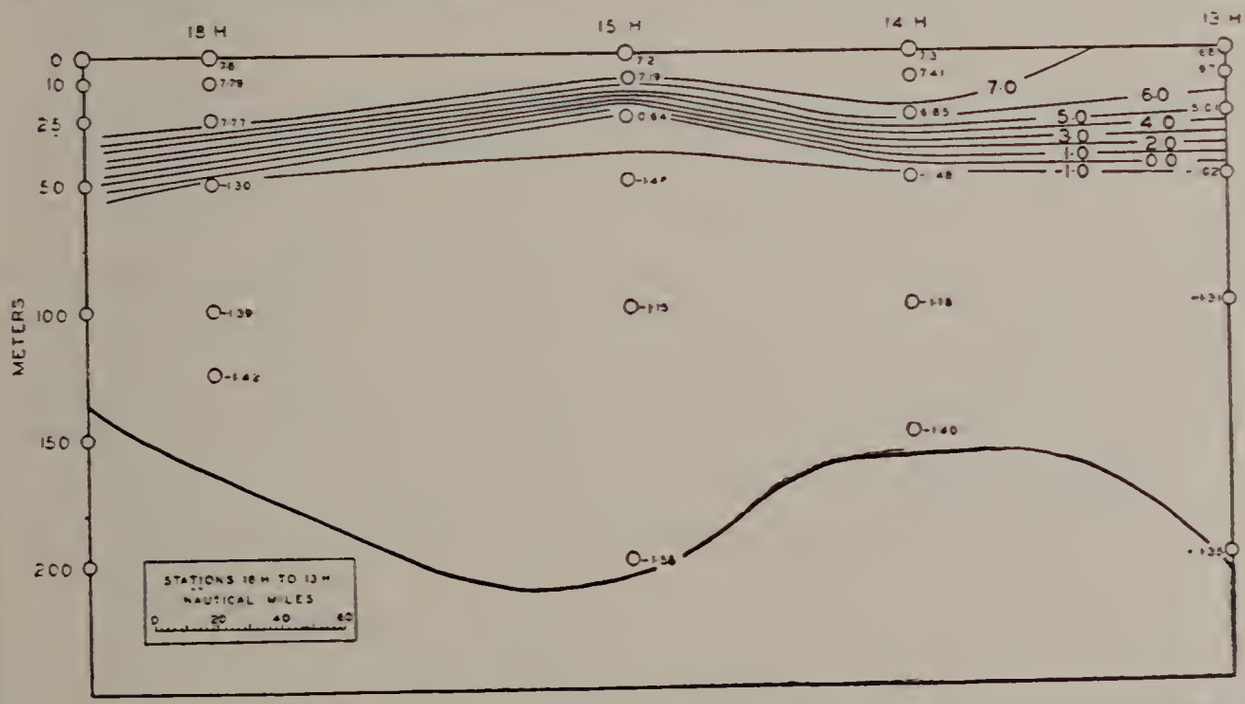

Figure 7. Temperatures in section in Hudson Bay September 9-16, 1948

On the surface, temperatures are greater than 6.8° C., with a high of 7.8° C. at station 18H. All salinities down to the 25 metre level are less than 31.00 °/₀₀. In the vicinity of stations 14H and 15H a body of water of salinities less than 29.30 °/₀₀ is found.

Typical bathythermograph traces, running in succession from Hudson Bay to the mouth of Hudson Strait, are shown in Figure 9. The waters of Hudson Bay, as indicated by these

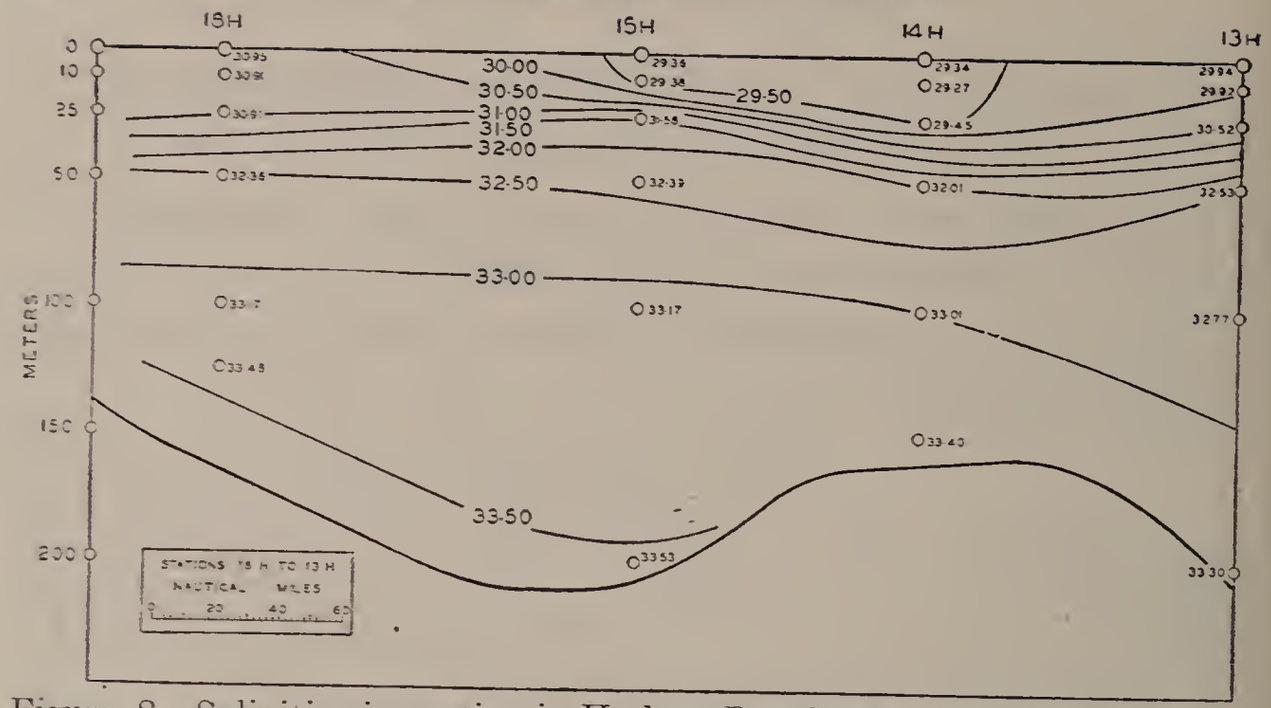

Figure 8. Salinities in section in Hudson Bay September 9-16, 1948.

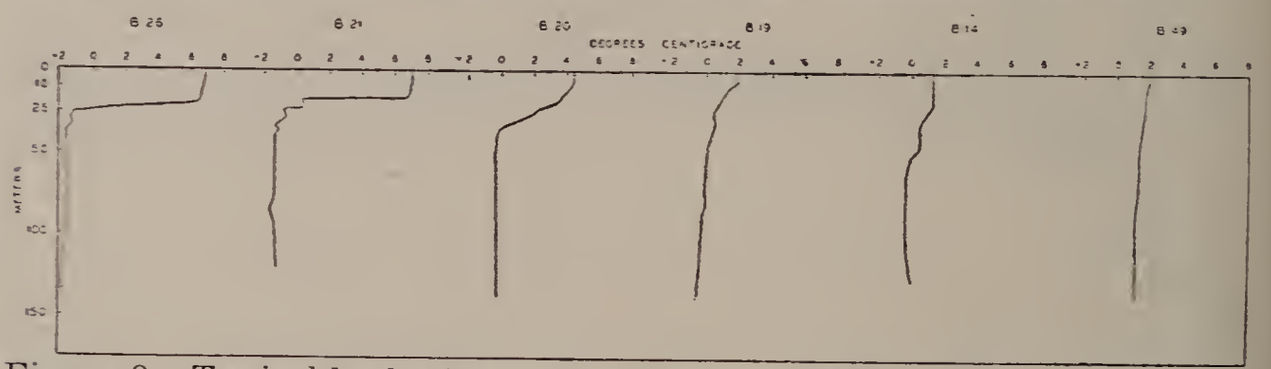

Figure 9. Typical bathythermograph traces in Hudson Bay and Hudson Strait running in succession from Hudson Bay to the mouth of Hudson Strait.

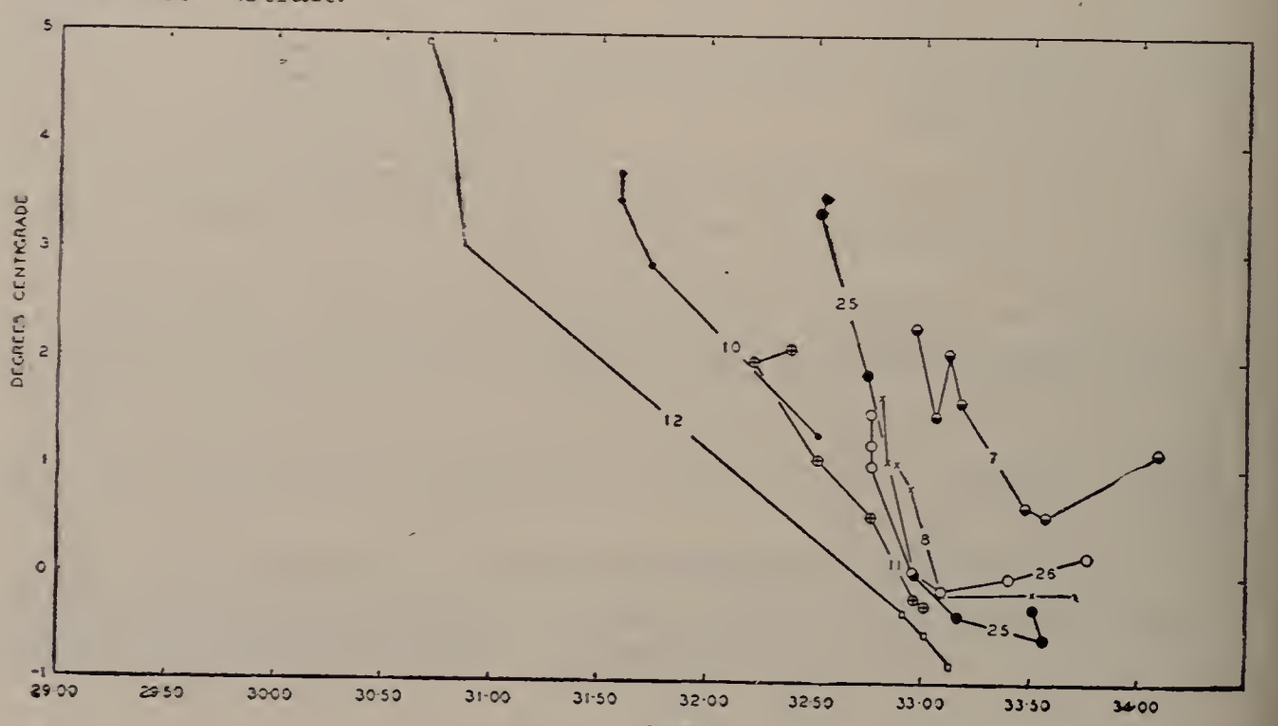

Figure 10. Temperature-Salinity correlation curves for Hudson Strait in September, 1948.

traces, are shown to have a very marked transition between the surface waters, which are warm and nearly isothermal, and the cold isothermal main body of water in the bay. On approaching Hudson Strait the depth of the isothermal surface layer is seen to decrease and the main body of water seems perceptibly warmer. On passing through Hudson Strait the increased temperature of the deep waters and the lowered temperature of the surface waters are indicative of vertical mixing, until, at the mouth of Hudson Strait, all of the water to a depth of 150 metres has a uniform temperature of approximately 2.0° C. Thus a decrease of 5.0° C. in temperature at the surface and an increase of 2.8° C. at the 100 metre level are to be observed in the west to east passage through Hudson Strait.

Temperature-salinity diagrams

On the basis of the observations made from "Haida" in September, 1948, the temperature and salinity relationships in Hudson Strait are shown in Figure 10. The diagram gives pre-eminence only to two characteristic water masses as follows:

(a) A-water exhibiting temperatures greater than 3.5° C. and salinities between 30.50 and 32.00 °/₀₀;

(b) B-water exhibiting temperatures between -0.8 and 0.1° C., and salinities between 32.90 and 33.80 °/₀₀.

The character of A-water, found at the surface, is greatly influenced by land drainage which causes a large variation in salinities. B-water, found below the fifty metre level, has the characteristics of Baffin Land Current water (Smith, Soule and Mosby, 1937) and is probably of the same characteristics as Foxe Basin water. There are indications of the influence of water of the West Greenland Current as indicated by salinities greater than 33.50 °/₀₀ (Smith, Soule and Mosby, 1937). All other water is a mixture of A-water and B-water.

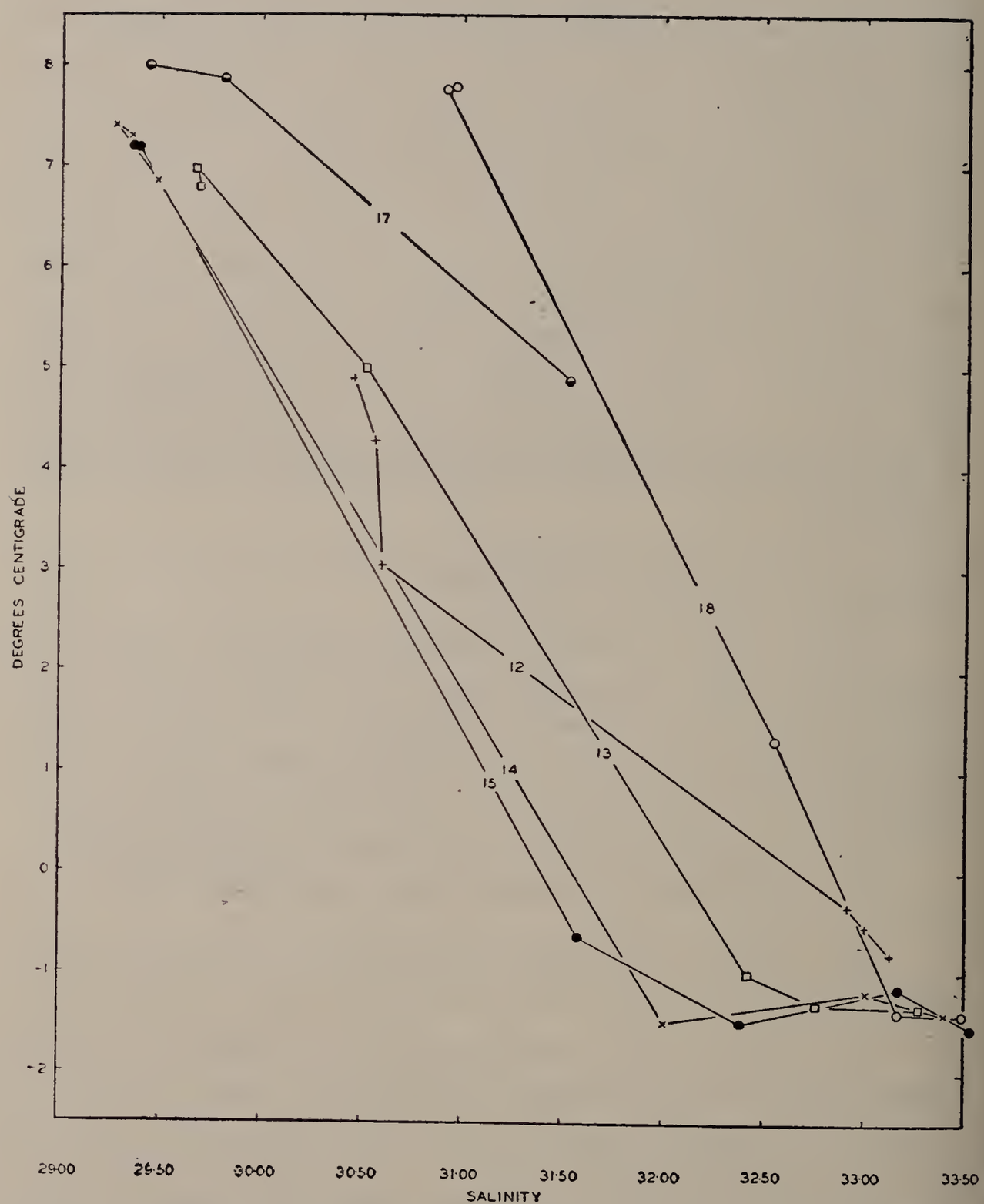

Figure 11. Temperature-Salinity correlation curves for Hudson Bay in September, 1948.

The T-S diagram shows that the inner stations in Hudson Strait (stations 11H and 12H) tend to be colder at greater depths than the outer stations 8H, 25H, and 26H. The latter stations contain waters of the Baffin Land Current, slightly modified, at greater depths, by the West Greenland Current, while the former stations contain waters from Foxe Basin.

The temperature and salinity relationships in Hudson Bay in 1948 are shown in Figure 11. Two characteristic water masses are indicated as follows:

(a) C-water exhibiting temperatures greater than 4.0° C. and salinities less than 31.50 °/₀₀;

(b) D-water exhibiting temperatures between -0.5 and -1.5° C. and salinities between 32.00 and 33.50 °/₀₀.

C-water is of the surface layer which is largely influenced by land drainage and surface warming. D-water found below the fifty metre level is, probably in greater part, surface water that has cooled during the winter when the surface waters have salanities greater than 32.00 °/₀₀ and has sunk to its own density level. In lesser part, D-water contains the higher salinities derived from water movements from Foxe Channel or Hudson Strait.

A comparison of the waters of Hudson Bay in 1930 and 1948

The temperature and salinity relationships in Hudson Bay in 1930 (Hachey, 1931) are shown in figure 12, and, in comparison with 1948 (figure 11), the characteristic D-water may be described as follows:

(a) 1930, exhibiting temperatures between -0.5 and 1.8° C. and salinities between 31.00 and 33.20 °/₀₀;

(b) 1948, exhibiting temperatures between -0.5 and -1.5° C. and salinities between 32.00 and 33.50 °/₀₀.

In addition it will be noted that salinities greater than

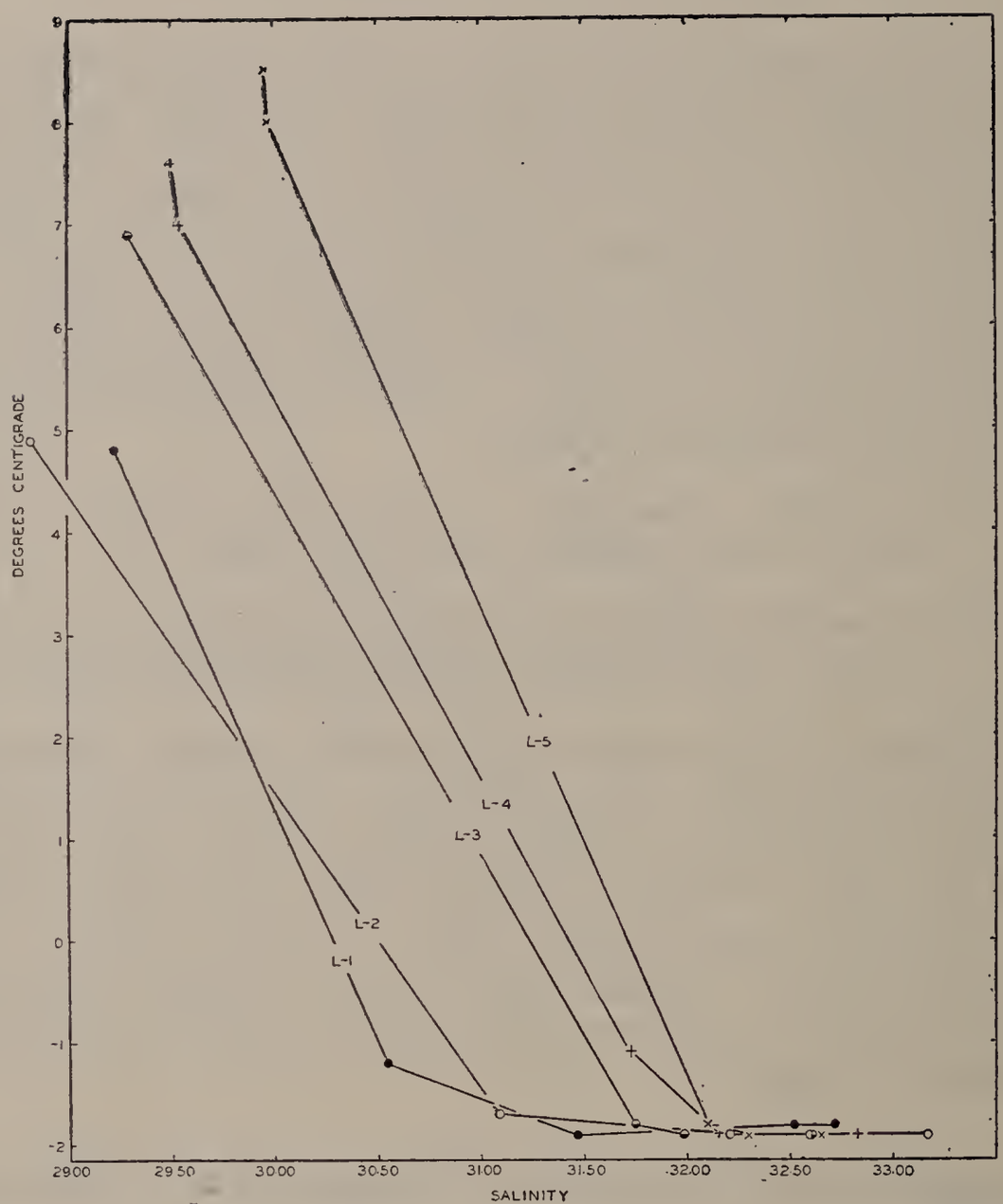

Figure 12. Temperature-Salinity correlation curves in Hudson Ba yfor August, 1930.

32.80 °/₀₀ were found only at one station in 1930, and were found at all stations in 1948. The deeper waters were generally of lower temperatures in 1930 than in 1948.

Discussion

Observations made in 1930 showed that below fifty metres the water temperatures were at least -1.8 °C. with corresponding salinities from 31.50 to 33.17 °/₀₀ (Hachey, 1931). It was concluded that the waters below fifty metres were for

all purposes dynamically dead, thus resulting in a cold, saline body of water which probably undergoes very little change from season to season. The observations in 1948 would indicate that the waters of Hudson Bay are not dynamically dead, but that there is a strong influence from the oceans through Foxe Channel and Hudson Strait. This is clearly indicated by the higher temperatures and salinities in 1948 as compared to 1930. In particular, the higher salinities are of greater significance, not only in indicating that replacement of the deeper waters does take place, but also in reflecting an increased Atlantic influence in the Sub-Artic waters.

Increasing Atlantic influence in the Greenland area as indicated by increasing salinities, the retreat of the sea ice, the weakening of Arctic water, important changes in marine fauna, including commercial fishes, and the marked reduction in the transportation of floe ice from east to west Greenland waters, has been discussed by various writers (Dunbar, 1946). This increasing Atlantic influence would seem, on the basis of the comparatively higher salinities in the deeper waters in 1948, to be reflected in the Hudson Bay area. Hudson Bay would seem to offer an excellent area for studying phenomena associated with the pulsation of the Atlantic influence in the Sub-Artic. The opportunity to study the vagaries of Arctic influence through observations of the water movements of ice and water from Foxe Basin and Channel is equally important.

Summary

I The temperature and salinity distributions in a section running through Hudson Strait are described for September, 1948, as having the main body of water of temperatures between 1.0 and -0.6° C. with salinities greater than 32.50 °/₀₀ and generally less than 34.00 °/₀₀, while on the surface, temperatures greater than 3.5° C. and salinities less than 32.00 °/₀₀ are found.

II The main features of the waters of Hudson Strait so shown by the sections are:

(a) the decreasing stratification both as to temperature and salinity in the upper 50 metres from west to east;

(b) the vertical mixing, as shown by the comparative uniformity of temperatures and salinities in the eastern portion of the strait, and

(c) the increasing temperatures of the main body of water below fifty metres from west to east.

III The temperature and salinity distributions in section are described for Hudson Bay in September 1948 as having:

(a) a marked stratification in the upper 50 metres,

(b) the main body of cold water below 50 metres with temperatures less than -1.0° C. and salinities from 32.50 to 33.50 °/₀₀, and

(c) a nearly isothermal surface layer to depths of 10 to 25 metres with temperatures as high as 7.8° C. and salinities as low as 29.30 °/₀₀.

IV Typical bathythermograph traces taken in Hudson Strait show a decrease of 5.0° C. in temperature on the surface, and an increase of 2.8° C. at the 100 metre level in the west to east passage through Hudson Strait.

V. Temperature and salinity diagrams for Hudson Bay and Hudson Strait are discussed for September 1948 and show the waters to be derived from two different water masses in each case.

VI. The waters from Baffin Land Current and from Foxe Basin are shown to exhibit similar temperature and salinity characteristics.

VII. The observations in 1948 indicate that replacement of the deep waters of Hudson Bay takes place on a large scale, the higher salinities observed, as compared to 1930, reflecting an increased Atlantic influence.

Acknowledgements

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THE VERTICAL TEMPERATURE STRUCTURE OF THE LABRADOR CURRENT

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Abstract

The observations discussed were collected during the "Northern Cruise" of H. M. C. ships in September, 1948 while in the Labrador Current. The vertical temperature structure of the waters of the Labrador Current in the main water mass is shown to be quite stable and fairly uniform in temperature characteristics, undergoing only normal seasonal changes in the surface layers within the month of September.

INTRODUCTION

Written accounts of explorations of the Labrador Sea date back to 1266, recording details of a Norse expedition which reached the region of Smith Sound. The first recorded crossing of the Labrador Sea was by Frobisher in 1576, and, in the latter half of the nineteenth, and the early part of the twentieth centuries, considerable detailed oceanographic observations were made in this area.

It was not until the "Chance" expedition of 1926 that an attempt was made to study the detailed physical and chemical structure of the Labrador Current (Iselin, 1927). In the period 1928-35, the "Marion" and "General Greene" expeditions, sponsored by the U. S. Coast Guard, made intensive and detailed study of the waters of the Labrador current (Smith, Soule and Mosby, 1937).

In 1948 a northern cruise of H.M.C. ships provided the opportunity of making certain limited observations in the Labrador Current while on board H.M.C.S. "Haida" under Lieut-Commander Pickard. While in the Labrador Current, ten hydrographic stations were occupied by the "Haida", seven while proceeding northward and three on the return journey. At each hydrographic station water samples and

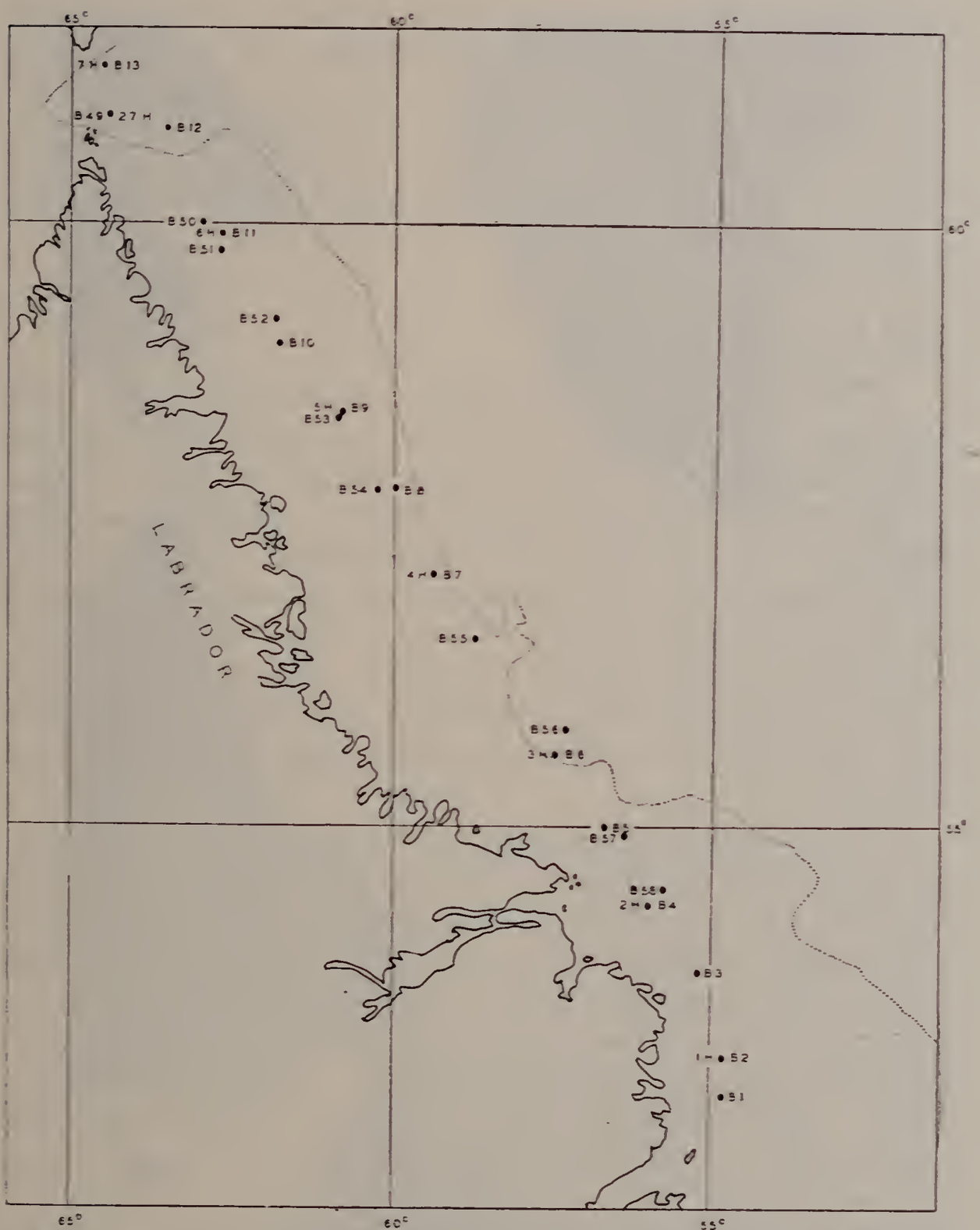

Figure 1. Labrador coastal waters showing the positions of "Haida" observations in September, 1948.

temperatures were obtained at depths of 0, 10, 25, 50, 100, 150, 200 and 250 metres. Throughout the cruise, bathythermographic observations were taken at intervals of approximately 50 miles, to depths of 150 metres. A map of the Labrador coast given in Figure 1 shows the hydrographic stations and the positions of bathythermograph observations during September, 1948.

The Labrador Current

The Labrador Current has been described (Iselin, 1927) as a cold water stream which flows southward over the continental shelf inside of the comparatively motionless homogeneous mass of North Atlantic water. As compared with the main body of water in the Labrador Sea, the current is characterized by its low salinity and temperature. As a result of the investigations of the "Marion" and "General Greene" expeditions (Smith, Soule and Mosby, 1937), the Labrador Current is found to have its origin in the vicinity of Cumberland Sound where the West Greenland and Baffin Land Currents join.

The Labrador Current may be divided into two streams, an inshore and an offshore one. The inshore stream contains the greater volume of the cold water and is confined to the continental shelf. This stream enters Hudson Strait on the Baffin Land side, and flows as far as Big Island before it recurves southward to mix with the waters flowing out of Hudson Bay, and flows out past Cape Chidley (Smith, Soule, and Mosby, 1937). The offshore stream which contains waters that are characteristic of the warmer West Greenland Current, tends shorewards near the mouth of Hudson Strait, but does not enter, and continues to flow southward over the continental slope (Smith, Soule and Mosby, 1937). Continuing down the coast, the Labrador Current follows an easy sinuous course which exhibits two major bends, the one between Cape Harrigan and Cape Harrison, Labrador, and the other between

Figure 2. Labrador Current July 22 - September 17, 1928. The velocities shown in miles per day indicate the axis of maximum flow.

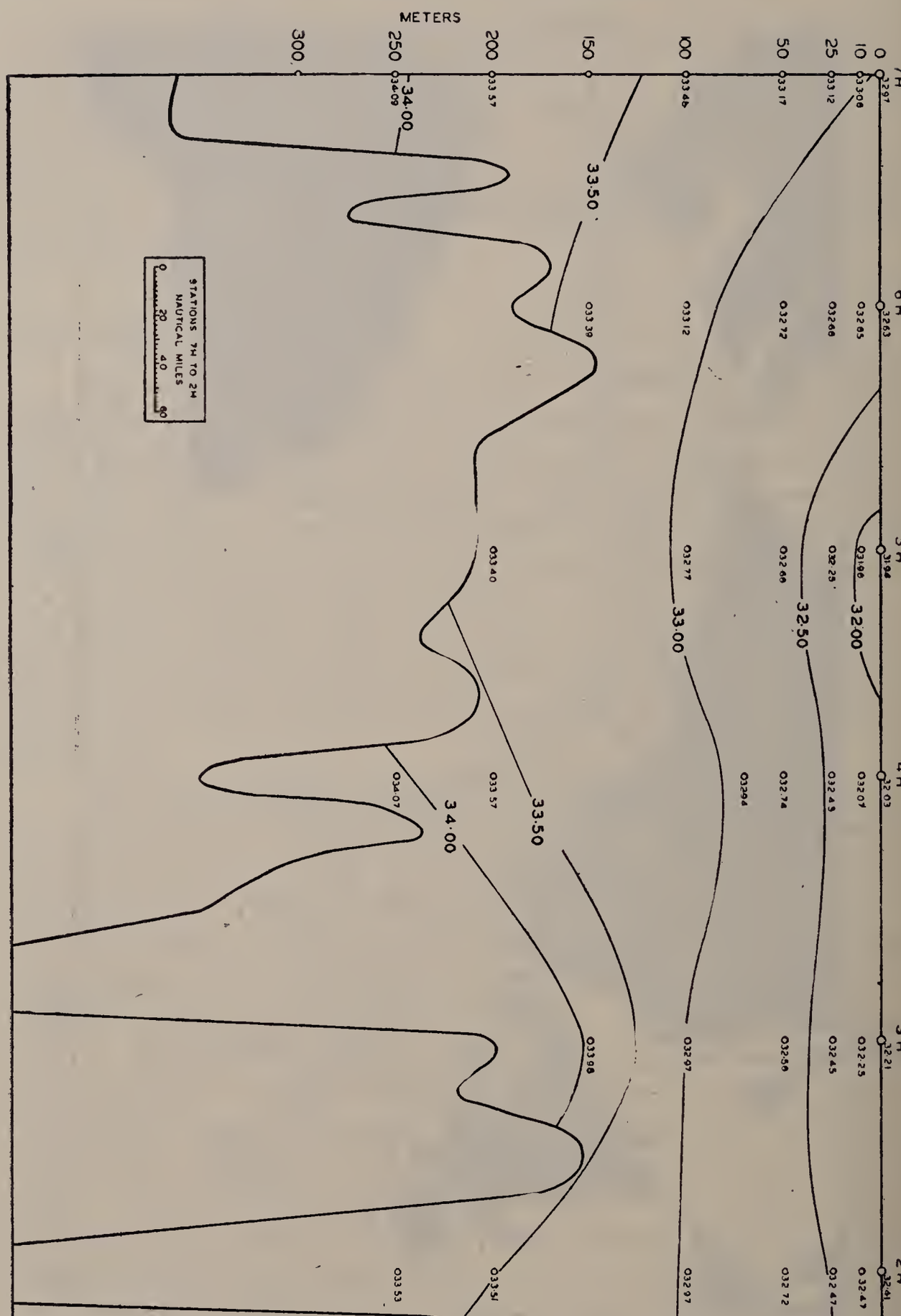

Figure 3. Temperatures in section September 4-6, 1948, running northwest up the Labrador Coast.

Cape Bauld and Funk Island, Newfoundland (Smith, Soule and Mosby, 1937).

The characteristic low temperatures of the Labrador Current persist as the water flows southward, the great stability of the water layers preventing the penetration of solar heat by convection. On reaching the vicinity of Belle Isle Strait, water from the inshore stream is carried, at times, through Belle Isle Strait, water moving outward along the southern side of Belle Isle Strait entering into the southward flow of the Labrador Current. Continuing southward of Belle Isle Strait, the Labrador Current meets the northern face of the Grand Banks in the latitude of St. John's, and is split, the slope branch continuing down the edge of the Grand Banks, while an inshore branch follows the fully past Cape Race (Smith, Soule and Mosby, 1937).

A velocity diagram of the Labrador Current (Smith, Soule, and Mosby, 1937) is shown in Figure 2, and the axis of maximum flow is indicated by the velocities shown in miles per day.

In section, from southeast to northwest, the distribution of temperature and salinity in the Labrador Current in September is shown in Figures 3 and 4, the locations of the hydrographic stations occupied being indicated in Figure 1.

Near the axis of the Current, the main water mass constituting the Labrador current between depths of 25 and 250 metres has temperatures from 2.0 to -0.4° C. and salinities ranging from 32.50 to 33.50 °/₀₀. To some extent, the surface layer to depths of 25 metres is influenced by surface warming and land drainage, with temperatures greater than 4.0° C. and salinities less than 32.00 °/₀₀.

A large body of cold water of temperatures less than 0.0° C. and salinities between 33.00 to 33.50 °/₀₀ is located in the southern portion of the section. This is arctic water which, on the basis of salinity, is either continuous with an offshore water moving southward along the edge of the shelf, or the last vestiges of the southerly movement of Arctic water masses

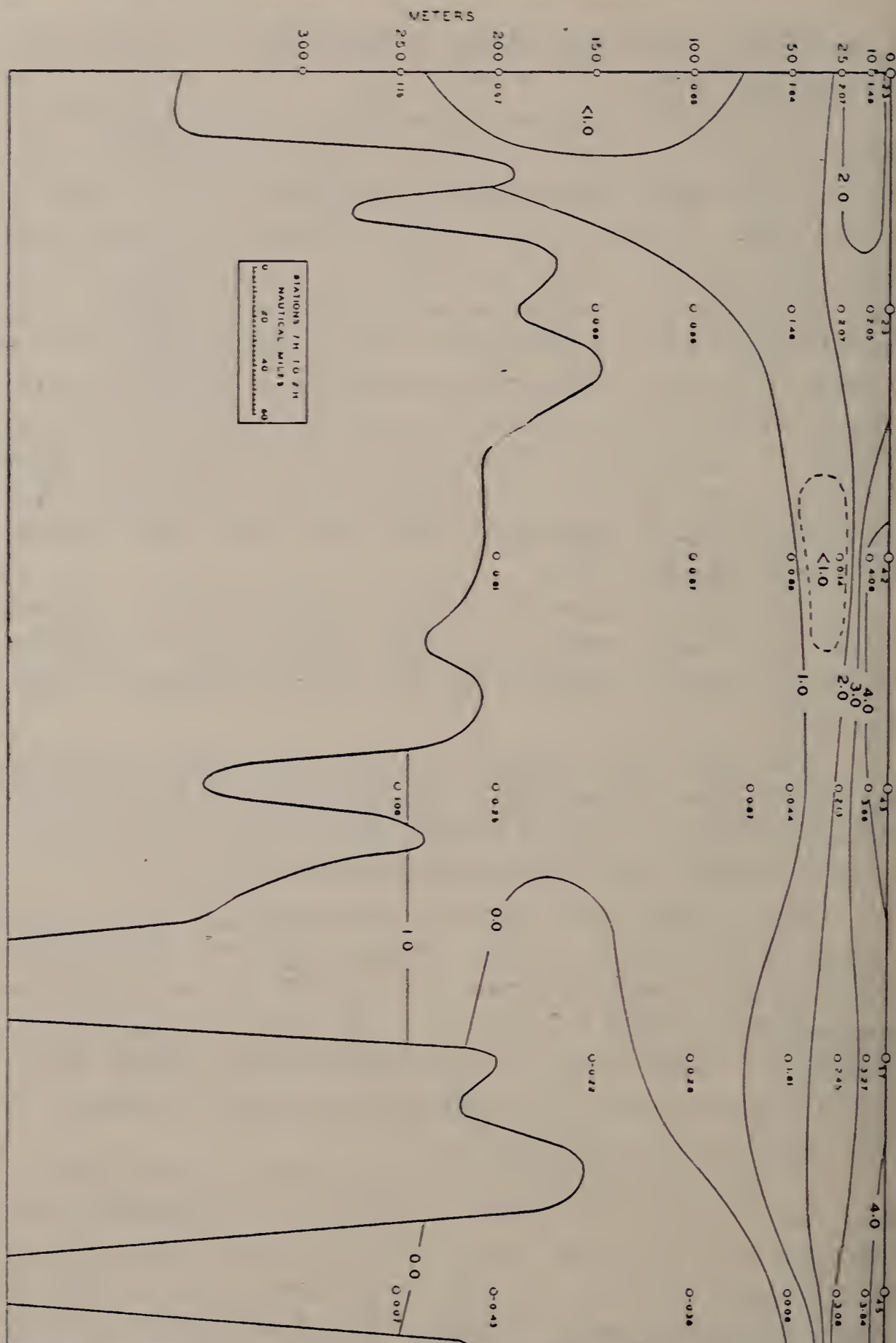

Figure 4. Salinities in section September 4-6. 1948, running northwest along the Labrador coast.

which predominate in the early months of the year (p. 122, Smith, Soule and Mosby, 1937).

In the extreme northern portion of the section (station 7H), in the vicinity of the entrance to Hudson strait, a comparative decrease in stratification, both as to temperature and salinity, is indicative of an area of mixing. Here also, at depths of 75 to 250 metres, is located a water mass of temperatures less than 1.0°C. and of a salinity of approximately 33.50 ‰. On the basis of temperature and salinity characteristics this mass of water originates from the Baffin Land Current.

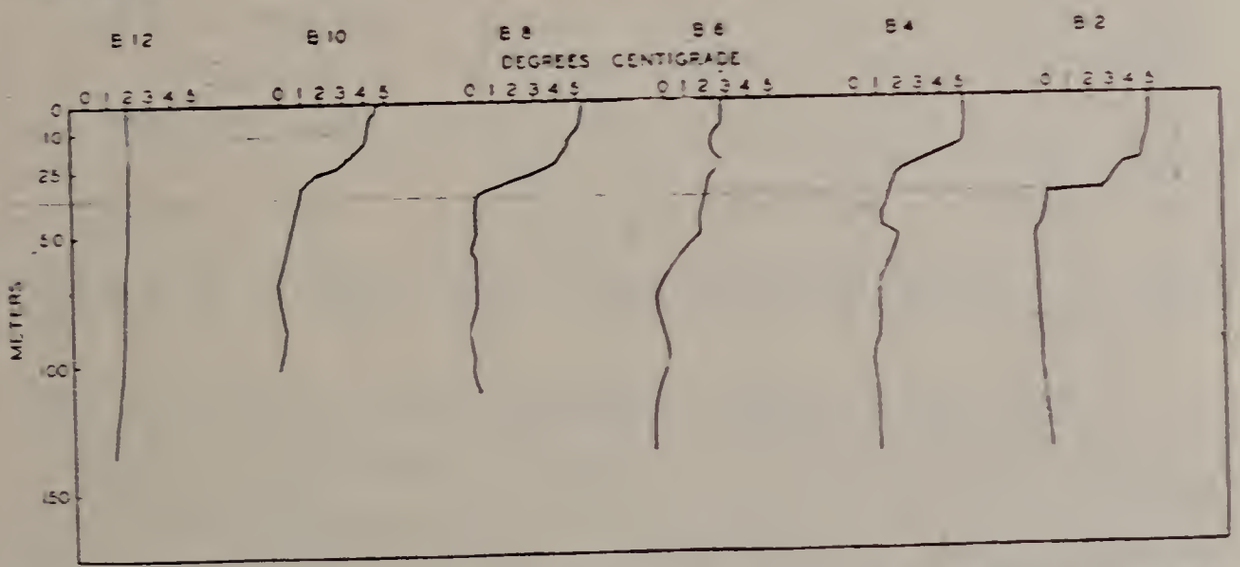

Figure 5. Temperature-Salinity correlation curves for Labrador coastal waters in September, 1948.

Temperature-salinity diagrams

On the basis of observations made in 1931 by the "Marion" and "General Greene" expedition, temperature-salinity correlation curves were obtained for all observations below a depth of 50 metres in the Labrador Current (p. 112, Smith, Soule and Mosby, 1937). These correlation curves show that the main water mass of the Labrador Current is a mixture of two characteristic waters as follows:

(1) Baffin Land water exhibiting average temperatures of -0.5 °C. and average salinities of 33.50 ‰;

(2) West Greenland water exhibiting temperatures as high as 3.8° C. and salinities as high as 34.60 °/₀₀.

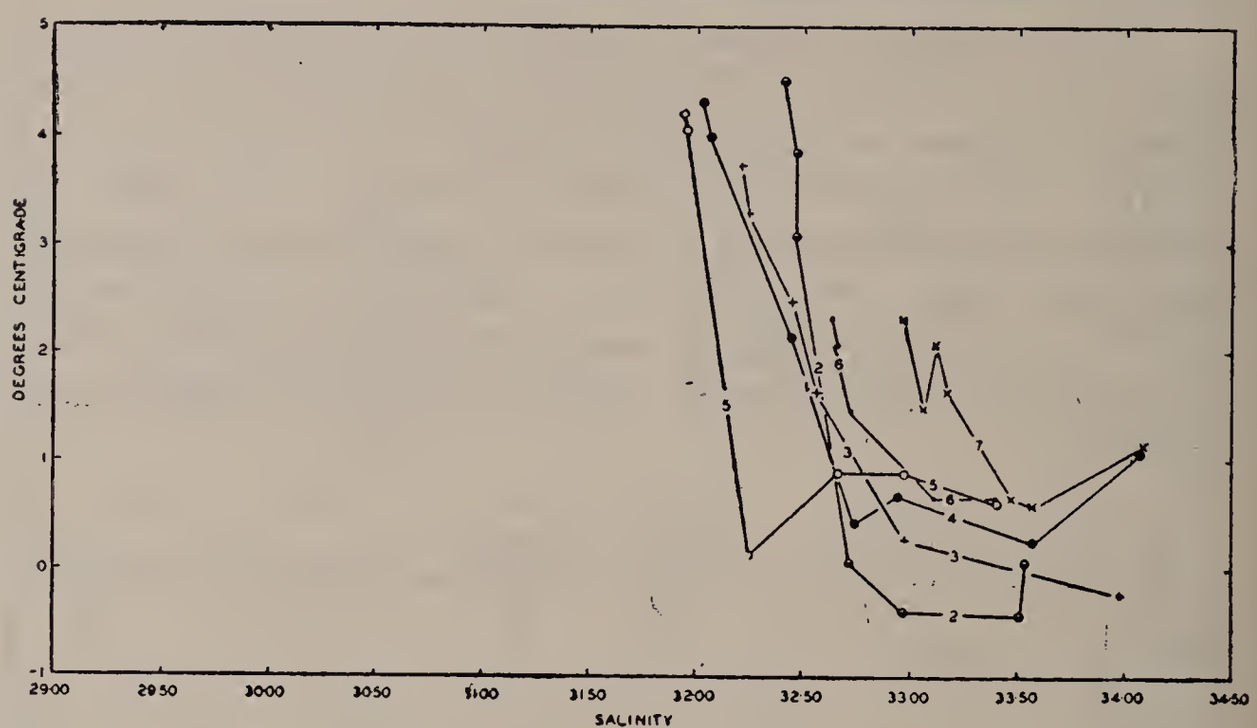

Figure 6. Typical Bathythermograph traces taken in the Labrador Current.

A temperature-salinity diagram was constructed from the 1948 data collected by the "Haida", and shown in Figure 5. As the "Haida" data were collected only along the axis of the Labrador Current, and to depths not exceeding 300 metres, the diagram gives pre-eminence only to two characteristic water masses as follows:

(1) A-water exhibiting temperatures greater than 3.0° C. and salinities between 32.00 and 32.50 °/₀₀;

(2) B-water exhibiting temperatures between -0.5° C. and 1.0° C. and salinities between 32.70 and 34.00 °/₀₀.

The A-water is therefore representative of the coastal contributions to the Labrador Current, and confined, in the main, to the upper fifty metres within the coastal belt. The B-water is obviously water of the Baffin Land Current, while no sampling of the waters of the West Greenland Current is in evidence.

The bathythermograph (Spilhaus, 1938), giving a con-

tinuous record of water temperatures from surface to depth, provides an excellent means of examining in detail the vertical temperature structure of a water mass. While in the Labrador Current, bathythermographic observations were taken from the "Haida" at intervals of fifty miles from Belle Isle Strait northward and again on the return journey. Twenty-two observations were made, twelve in early September and ten in late September. Positions of the points of observations are shown in Figure 1. Typical records are shown for early September in Figure 6.

The development of temperature stratification, as indicated between station 12B, off Hudson Strait, and station B2, north of Belle Isle is the main feature of the observations. The changing temperature characteristic of the main water mass, below 50 metres, from 0.0°C. or less at stations B2, B6, and B8 to 1.0°C. or greater at stations B4 and B12 might indicate that the sampling was not altogether along the axis of the Current. There are also traces of intrusions of small tongues of water seemingly foreign to the main water mass. These are indicated at stations B6 at depths of 10 to 30 metres and B4, at depths of 50 to 75 metres. The variation in thickness of an approximately isothermal layer from 5 metres at station B10 to 20, 17, and 25 metres at stations B8, B4, and B2 respectively, is another feature of interest.

The bathythermographic observations taken in the Labrador Current were plotted to illustrate the vertical temperature structure in section. The data for early September based on twelve bathythermograms are plotted in Figure 7, and the data for late September, based on ten bathythermograms are plotted in Figure 8. While the general features of the temperature structure as presented in Figures 6 and 7 are similar to those in Figure 2, the bathythermograms allow for a more precise determination of the temperature fine structure within the Current.

The early September section (Figure 6) shows several important features. There is a general stratification in the up-

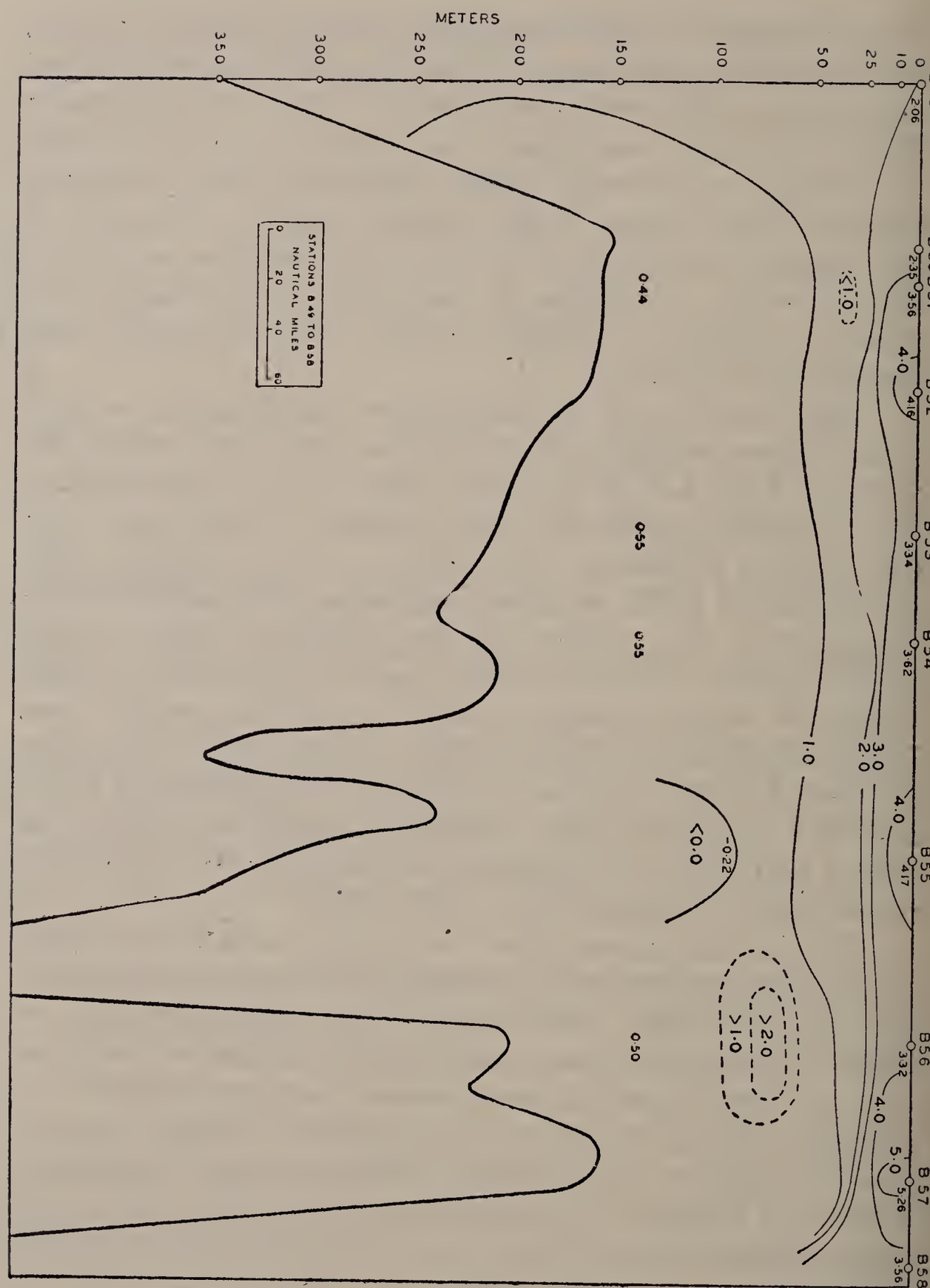

Figure 7. The Temperature structure of the Labrador current in September 4-6, 1948.

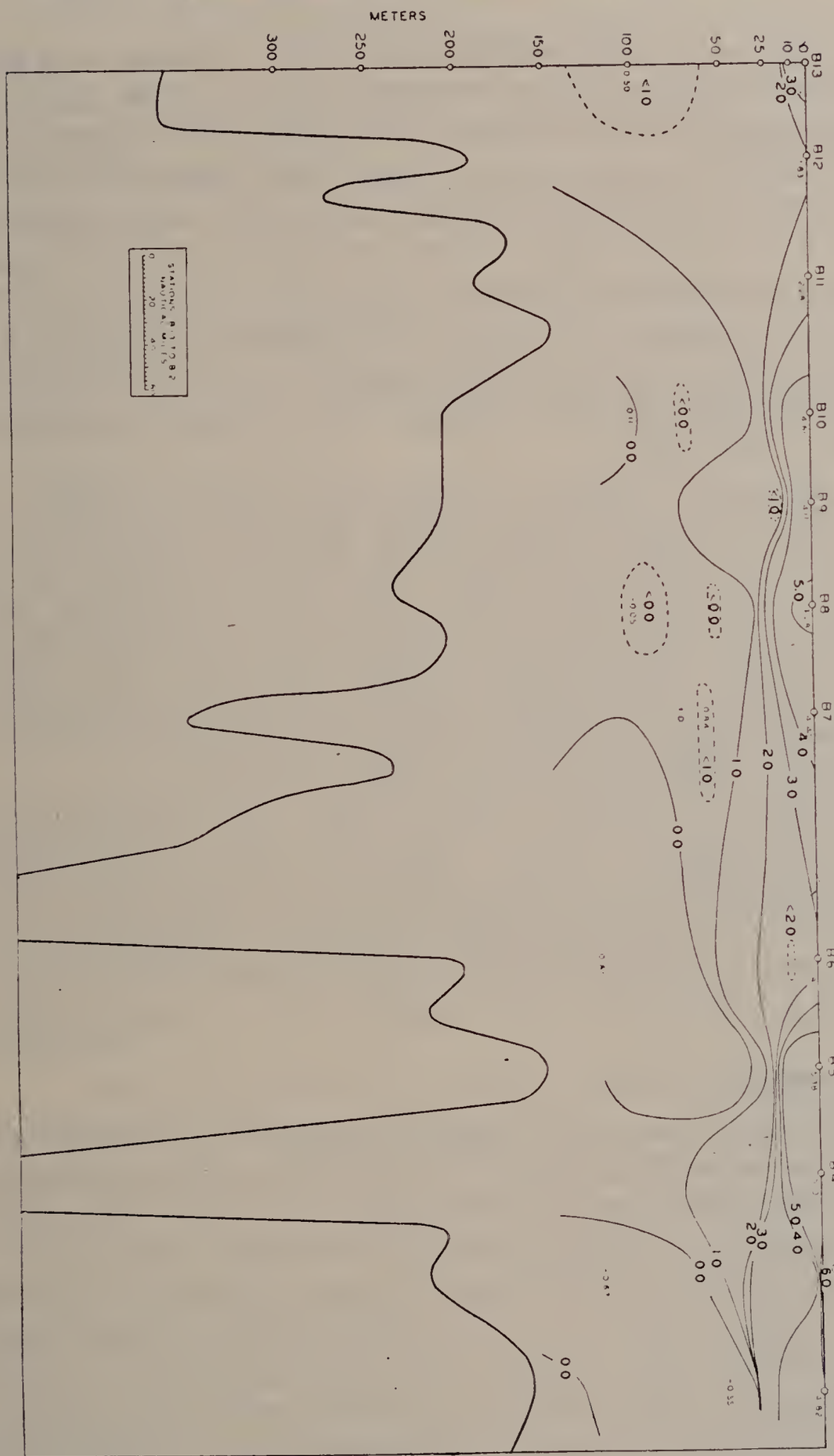

Figure 8. The temperature structure of the Labrador current in September 23-25, 1948.

per 50 metres that deepens towards the southern end of the section. This is clearly indicated by the depth of the isotherm of 2.0° C. which appears at a depth of 25 metres in the north and 45 metres in the south. The waters below the 50 metre level are, on the average, below 1.0° C. with a minimum of -0.67° C. Near Hudson Strait, the discontinuity of the isotherms at station B12 indicates that this is an area of strong mixing. Although the intensity of mixing is not as great as at station B12, the area of mixing appears to extend from south of station B11 almost to station B13, a distance of approximately 110 miles.

In various portions of the section traces of water temperatures, seemingly foreign to the main water mass, are to be found. In some cases these are probably tongues of cold water extending outward from the coast. The main water mass is of a temperature between 0.0. and 2.0° C., and the after effects of the summer season are shown in the surface layer, which at no point is thicker than 45 metres, and with the highest temperature in the vicinity of 5.0° C.

The late September section (Figure 8) exhibits the same general features as that for early September, with autumnal cooling and resultant vertical mixing shown in the surface layer by lowered temperatures and decreased stratification. One prominent tongue of comparatively warmer water has protruded into the section in the neighbourhood of station B 56.

Discussion

On the basis of the temperature-salinity characteristics of the water sampled at the "Haida" stations while proceeding in the Labrador current, in September 1948, it is obvious that the track of the "Haida" was in a water mass contributed, to a large extent, by the Baffin Land current, and that any water mass sampled was either of the Baffin Land Current, or a mixture of these waters with waters of coastal origin, and/or modification. Hence the water masses originating from the West Greenland Current or in the intermixing of water of the

West Greenland Current and Baffin Land Currents were on the ocean side of the "Haida" track. It has been estimated that the average volume of water contributed to the Labrador Current by the West Greenland Current and the Baffin Land Current is in the proportion of 3 to 2 (Smith, Soule, and Mosby, 1937).

The vertical temperature structure of the waters of the Labrador Current in the main water mass is shown to be quite stable and fairly uniform in temperature characteristics, undergoing only normal seasonal changes in the surface layer within the month of September.

The dynamics of the Labrador Current is to a large extent associated with a mixing process where waters of the West Greenland Current and Baffin Land Currents merge. While this merging probably takes place over a considerable area in Davis Strait and Baffin Bay and particularly along the continental shelf adjacent to Baffin Island, there is indicated by our observations a large area of mixing in the region of Hudson Strait, where probably waters from Hudson Bay and Foxe Channel merge with waters of the Baffin Land Current to create what might be termed Labrador coastal water. In any event, this additional mixing process gives acceleration to the southward movement of northern waters.

Summary

1. The temperature and salinity distributions in a section along the axis of the Labrador Current is described for September 1948, as having the main body of water at depths of 25 to 250 metres with temperatures between 2.0 and -0.4°C., and salinities ranging from 32.50 to 33.50 °/₀₀, while on the surface temperatures greater than 4.0°C. and salinities less than 32.00 °/₀₀ are found.

2. The vertical temperature structure of the water mass along the axis of the Labrador Current has been examined in some detail which reveals:

(a) The development of temperature stratification with variations in the thickness of an approximately isothermal layer from 5 metres at station B10 to 20, 17 and 25 metres at stations 8B, B4 and B2.

(b) Near Hudson Strait the discontinuity of the isotherms indicates an area of strong mixing which extends 110 miles southward from station B13.

(c) Tongues of cold water from inshore are protruding into the section.

(d) The temperature of the main water mass is between 0.0 and 2.0°C.

(e) Autumnal cooling with resultant vertical mixing is in evidence during September.

3. The vertical temperature structure of the water of the Labrador Current in the main water mass is shown to be quite stable and fairly uniform in temperature characteristics, undergoing only normal seasonal changes in the surface layer within the month of September.

Acknowledgements

The observations discussed herein were made possible through the co-operation of the Defence Research Board of Canada, the Royal Canadian Navy, and the Canadian Joint Committee on Oceanography, and this paper is published with their permission

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PRESIDENTIAL ADDRESS

NOVA SCOTIAN INSTITUTE OF SCIENCE

88th Annual Meeting. Oct. 17, 1949.

REPORT OF THE PRESIDENT

It is my duty at this point to summarize the activities of the Institute during the past year and to report to the members some of the deliberations of Council. It has been an active year but before describing it I must record our loss by death of three of our members.

Dr. A. M. Fraser, Professor of Pharmacology at Dalhousie, had been a member for only a year. Nevertheless he was a keen scientist and in him we have lost one who gave promise of active contributions to our Society.

Professor H. E. Bigelow, Professor of Chemistry, Mount Allison University, a distinguished scientist and one time member of National Research Council, had been an associate member since 1929 and an honorary member since 1947. He has long shown an interest in the affairs of the Institute and we have lost a friend.

In Professor G. H. Henderson's untimely death we have lost one of our most active supporters and one of our sagest counsellors. He was a student member in 1915 and was our President from 1936-1938, and he has served from time to time on Council and on the Editorial Board. As a Fellow of the Royal Society, a Fellow of the Royal Society of Canada, a member of the National Research Council, and for his work on Naval Research, he has been recognized as one of Canada's leading scientists. His death is a loss to Canadian science as well as to us, and we extend to his family our sincere sympathy. Professor Bronson will speak to this later.

The past year has been a very active one, and from the point of view of figures at least, one of our most successful.

I have not the figures for the early years of our long history but in recent times at least in the past year all records for sustained activity have been broken. We held 7 Ordinary meetings, one each month during the season, at which 21 papers describing original research were presented, to an average attendance of 47. Of the 21 communications, 3 were in the field of Biochemistry, 4 in Biology, 1 in Chemistry, 1 jointly in Chemistry and Biology, 2 in Geology, 3 in Pharmacology, 4 in Physics, and 3 in Physiology. Five of the papers were accompanied by demonstrations.

Our membership is about 200, somewhat higher than last year, but of these only 74 are Ordinary members. We need more Ordinary members if we are to maintain a healthy growth and we should all endeavor to interest more of our science minded colleagues to join us and contribute to our discussions.

There is at present a great expansion in research facilities taking place in this area, which I am sure will in the next few years result in a great increase in our membership and in our activities. In addition to the already productive laboratories from which so many of our members are drawn, the new programs of the Nova Scotia Research Foundation, the regional laboratory of the National Research Council that is now under construction, the Nova Scotia Technical College, and the recently formed Faculty of Graduate Studies of Dalhousie, must inevitably result in a greater interest in Science in the community. We can help ourselves and each of these bodies by bringing their workers together in free scientific discussions of their work and problems.

Your Council has experienced a busy year. Apart from the more or less routine affairs of the Institute the special problems which have taken its time have been concerned with our Exchange, our Proceedings, and our Library.

The Corresponding Secretary has done yeoman service in bringing the Exchange list up to date and to him our thanks are due. During the last two years, all the organizations on

the old list from which we have not heard for some years have been asked if they desired to continue or resume exchanges. As a result some have been dropped, but others have been added and the revised list contains only those desirous of continuing exchanges. The actual figures will be given in the secretary's report, but the exchanges are once again healthy and active and a source of strength to us.

The Editor has had to cope with high costs and with exasperating printer's delays but somehow, as his report will show, he has managed to get the work done. He has intimated, too, that the situation seems to be easing and that printing troubles may be expected to lessen from now on. The number of papers submitted is small but fortunately many of those that do come in are unique and worthy. I feel that our small publication serves a useful function and makes a valuable contribution to Nova Scotia. The problem of financing it becomes greater and more funds may soon be needed; this is being carefully watched by Council. It is evident that not many of the papers presented at our Ordinary Meetings will be published in our journal, but we should all try to persuade authors of papers of peculiar interest to Nova Scotia to send their papers to us. I cannot leave this subject without paying tribute to our faithful editor of the last 8 years, even though I have asked Professor Hayes to speak to this subject later. Dr. Ernest Hess has left us for greater fields and we must congratulate him on his new appointment and opportunities. However his going will leave a void with us and we shall miss him sorely.

The Library has given Council a great deal of concern. As you will remember, about a year and a half ago, the administration of the Provincial Science Library was transferred from the Library Commission to the Nova Scotia Research Foundation. This, for a time at least, has resulted in considerable confusion because it has not been possible to keep the library in one piece. Part of the Institute's portion has been moved to the excellent new Foundation library, part is

housed in space and shelves generously provided by the Nova Scotia Technical College, and the Provincial Science Museum is interested in another part. Your Council has named a library committee, with Dr. Chute as chairman, to look after our library, wherever it may be, and a beginning has been made in rearranging and shelving the older fyles. One of our tasks of the coming year is to complete the detailed lists of what we have and where material is to be found. Each of the organizations housing or utilizing our papers and volumes has agreed to catalogue them as belonging to the Institute and has recognized in writing the Institute's ownership. The Research Foundation is setting up a committee to administer their library, and they have asked the Institute to name two representatives to this committee.

The Museum. Traditionally, the Provincial Science Museum and The Institute, because of their overlapping interests, have ties in common. I would recommend that all of you who have not recently done so pay a visit to the museum. It is woefully short of enough space and funds to do even a fraction of what it wishes, but you will find a great change. No longer is it a mere repository for moth eaten birds, stinking half preserved fishes, and dusty poorly labelled rocks. Many of the present displays are elegant and a delight to see and study, and more are in preparation. The advent of the Nova Scotia Research Foundation has added a new note in the science organization of our community. Now, to the discussion and reporting of academic scientific research, which is our function, and to the educational display of scientific material which is the Museum's, there is added the duty of the Foundation to foster direct applied scientific methods and industrial research. These three bodies should be complementary to one another, and I feel that we of the Institute are fortunate in the interest and co-operation we have had both from the Foundation and the Museum, and also, I may add, from the Technical College and the Fisheries group.

I wish, in closing, to pay tribute to each of the officers and members of Council for their unfailing interest and counsel during the year. Comparisons would be invidious, all have given unselfishly of their time and effort to the interests of the Institute. To them my thanks, and also to the Institute for the honor of naming me its president.

PROCEEDINGS OF MEETINGS

Session of 1949–50

(Meetings were held in the Medical Sciences Building,
Dalhousie University, Halifax, N. S.)

88*th Annual Business Meeting*, October 17, 1949.

The President, Dr. C. B. Weld, presided over the meeting at which 20 members were present. His annual address is printed in full in the proceedings. Reports of Officers were presented and are summarized as follows;

Treasurer's Report;

Receipts	$	913.93
Expenditures		696.89
Total assets, current account		1,615.00
Total assets, permanent fund		4,000.00

The Corresponding Secretary reported that a total of 8 exchanges were set up during the year. In addition 56 back numbers were mailed out.

The Editor reported that Part 2 of Volume XXII is in press and that Part 3 is ready to go to press. He also submitted his resignation after 8 years in office.

The Librarian reported that in excess of 1500 publications had been received through the exchange list. A Library Committee to deal with our now-scattered holdings was set up.

Officers elected for the year 1949-50 were;

President	Dr. C. B. Weld
1st Vice-President	Dr. A. E. Cameron
2nd Vice-President	Dr. W. J. Chute

Treasurer.....Mr. R. E. S. Homans
Corresponding Secretary.....Dr. J. G. Aldous
Recording Secretary.....Dr. W. J. Dyer
Council.....Dr. H. D. Smith, Dr. L. G. Stephens-Newsham, Mr. R. E. S. Homans, Dr. R. W. Begg, and Dr. W. L. Ford.
Editor.....Dr. H. R. Chipman
Librarian.....Dr. W. J. Chute
Auditors.....Dr. R. J. Bean and Dr. H. L. Bronson

1*st Ordinary Meeting*, November 14, 1949.

The following new members were announced (elected by Council, October 31); Honorary, Dr. E. Hess; ordinary members, J. E. Blanchard, M.A., A. K. Reynolds, M.Sc., C. G. Oldershaw, B.A., Sc.; D. A. Redmond, B.Sc.; associate member, Rev. W. Rees-Wright, Ph.D.; student members, T. C. Noel, B.Sc.; D. D. Betts, A. H. Marshall, G. L. Williams, R. W. Wilson, F. S. K. MacMillan, B.Sc., P. C. Gordon, B.Sc., F. G. Inglis, J. W. Kastner, B.Sc., E. R. Hayes, B.Sc., Miss Pat Smith, B.Sc.

Papers: "The Systemic Effects of Malignancy", by R. W. Begg; "A Nutritional Survey of Young Children in Halifax, N. S.", by A. V. MacLeod and E. G. Young; "The Activity of Enzymes Extracted from Ultraviolet Irradiated Yeast Cells", by K. D. Stewart and J. G. Aldous.

2*nd Ordinary Meeting*, December 12, 1949.

The following new members were announced (elected by Council, December 12); John Fodden, M.B., M.D., G. L. Christie, Ph.D., J. R. Longard, M.Sc., A. W. Marris, M.Sc., ordinary members; D. L. MacCallion, Ph.D., associate member.

Papers: "The Influence of Adrenal Cortical Extract on the Systemic Effects of Tumors in Rats", by R. W. Begg,

T. E. Dickinson and D. G. Withers; "Exchange of Materials in a Lake as Studied by the Addition of Radioactive Phosphorus Below the Thermocline", by J. A. McCarter, F. R. Hayes, L. H. Jodrey, and M. L. Cameron; "The Effect of Tissue Disintegration on the Determination of Liver Catalase Activity", by T. E. Dickinson and R. W. Begg.

3rd Ordinary Meeting, January 16, 1950.

E. Chalmers-Smith, Ph.D., was announced as a new associate member (elected by Council, January 16).

Papers: "Thymus Tumors in Rats", by R. W. Begg; "Effect of Reverberation on Speech Intelligibility", by R. H. Bolt and A. D. MacDonald; "Some New Results on the Behaviour of the Gulf Stream", by W. L. Ford and F. C. Fuglister.

4th Ordinary Meeting, February 13, 1950.

Dr. C. M. Jones, M.D., was announced as ordinary member (elected by Council February 13).

Papers: "The Theoretical Computation of the Physical Properties of Simple Solids", by W. J. Archibald; "A Brief Theoretical Survey of Fluid Resistance of Variously Shaped Bodies", by A. W. Marris; "Spongilla Novae Terrae Potts; a Freshwater Sponge New to Nova Scotia", by M. J. Ord and M. L. Cameron.

5th Ordinary Meeting, March 13, 1950.

The following new ordinary members were announced (elected by Council February 27); P. L. Hoogland, Ph.D., R. P. Blake, B.Sc., B.E., T. H. Rogers, M.Sc.

Papers: "The Use of a Bolometer as a Molecular Beam Detector", by C. A. Reilly; "The Vertical Temperature Structure of the Labrador Current", by W. R. Bailey and H. B. Hachey.

6th Ordinary Meeting, April 3, 1950.

Papers: "An Increasing Atlantic Influence in Hudson Bay", by W. R. Bailey and H. B. Hachey; "A Further Experiment on the Addition of Radioactive Phosphorus to a Lake", by F. R. Hayes, J. A. McCarter, M. L. Cameron, and D. A. Livingstone; "A Calibrating Instrument for Simulating the Temperature and Pressure Conditions in the Sea", by J. R. Longard.

7th Ordinary Meeting, May 9, 1950.

Papers: "Electrophoretic and Enzymic Analyses of the Pancreatic Juice of the Dog", by G. M. Byrne, J. I. Phinney, M. Schachter, and E. G. Young; "The Activity of Enzymes Extracted from Yeast Cells Exposed to Radiation from Radon", by K. D. Stewart and J. G. Aldous; "A Cytological Study of the Ovotestis in Certain Pulmonate Gastropods", by Anne H. G. Watts; "The Cytology of the Molluscan Cell", by Muriel J. Ord.

ABSTRACTS

THE SYSTEMIC EFFECTS OF MALIGNANCY. R. W. Begg, Biochemistry Dept., Dalhousie University, Halifax, N. S. (Read November 14, 1949). Systemic effects in tumor-bearing animals are regarded as those changes which take place in tissues remote from the actual tumor, and in which no evidence is found of invasion by malignant cells. In rats bearing tumors, hemoglobin, liver catalase activity, adrenal and thymus weights, adrenal cholesterol, ascorbic acid, and liver glucogen were determined, and the adrenal glands subjected to histological examination. The material is presented to show that the degree of the systemic effects is a function of the relation of tumor size to body weight.

A NUTRITIONAL SURVEY OF YOUNG CHILDREN IN HALIFAX, N. S. Ada V. MacLeod and E. G. Young, Biochemistry Dept., Dalhousie University, Halifax, N. S. (Read November 14, 1949). A survey of 55 children, 1 to 6 years of age, has been carried out by means of dietary records, supplemented by anthropometric measurements, physical, urinary and hematological examinations, and assessment of age of calcification by radiographs. The observations were repeated after six months.

Quantitative data have been obtained relative to twelve essential nutrients, the levels of consumption have been compared with modern dietary standards, and have been considered in relation to physical state and growth. From the results it has been possible to construct curves relating body weight to consumption for some nutrients, and to arrive at average figures per kilogram or per 1000 Cals. for others. The period of two to three years of age has been shown to be a critical one in the nutrition of children.

THE ACTIVITY OF ENZYMES EXTRACTED FROM ULTRAVIOLET IRRADIATED YEAST CELLS. K. D. Stewart and J. G. Aldous, Pharmacology Dept., Dalhousie University, Halifax, N. S. (Read November 14, 1949). This investigation has been undertaken to determine whether the lethal action of ultraviolet light is a specific one on the enzymes of the intact cell or whether it is an all-or-none effect.

Suspensions of the cells of Baker's yeast were irradiated with sufficient dosage of the radiation to render 50 percent of the population non-viable. After washing, the cell preparation was dried and ground in a Wiley mill. From this powder various enzymes were extracted and their activities determined. The 'specific activity' of each preparation was expressed as;

$$\frac{\text{activity of aliquot}}{\text{N content (mg) of aliquot}}$$

Similar (control) preparations were made from unirradiated material and their specific activities determined. The results for five enzyme systems showed that cozymase, carboxylase, and hexokinase activities were all depressed by an amount in keeping with the depression of cell division (50 percent). On the other hand, alcohol and lactic dehydrogenases exhibited virtually no inhibition of activity.

THE INFLUENCE OF ADRENAL CORTICAL EXTRACT ON THE SYSTEMIC EFFECTS OF TUMORS IN RATS. R. W. Begg, T. E. Dickenson, and D. G.

Withers, Biochemistry Dept., Dalhousie University, Halifax, N. S. (Read December 12, 1949). From previous evidence it is apparent that rats bearing tumors pass through the stages of the 'alarm reaction' and come into a phase of adrenal cortical failure. Under the circumstances tumor bearing animals might be expected to benefit from the exhibition of adrenal cortical extract.

Upjohn's Lipo Adrenal Cortex was given in large doses to rats bearing the Walker 256 carcinoma and the effect on tumor and host compared with oil injected controls. Only the hemoglobin level was altered to a significant degree by the treatment. It is probable that some other factor than the adrenal cortical failure is responsible for malignant cachexia and death.

Exchange of Materials in a Lake Studied by the Addition of Radioactive Phosphorus Below the Thermocline. J. A. McCarter, F. R. Hayes, L. H. Jodrey and M. L. Cameron, Departments of Biochemistry and Biology, Dalhousie University, Halifax, N. S. (Read December 12, 1949). Approximately 100 millicuries of radioactive phosphorus in the form of potassium dihydrogen phosphate was introduced into the hypolimnion of a small acid-bog lake by causing a bottle containing a solution of the material to burst about 3 metres below the thermocline and about 1 metre above the bottom. The depth of water at the point of introduction of the bottle was 6 metres. After bursting the bottle the distribution of the radioactive phosphate through the waters of the lake was followed by withdrawing and analyzing samples of water from different localities and from different depths. Samples of ooze from the bottom of the lake were also taken for measurement of their content of radioactive phosphorus.

It was found that the radioactive phosphate moved through the hypolimnion in a lateral direction at a rate which did not exceed 1 foot per hour. Although it moved as far as 42 metres in a lateral direction, the extent of its movement vertically appeared to be not greater than about 1 metre, i.e., it did not penetrate the thermocline to a measurable extent. The radioactive phosphorus appeared early in the mud of the lake bottom, and its concentration there increased to such values as to suggest that the major part of the radioactive phosphorus added to the lake was removed by the mud, probably by a process of exchange of phosphate between the mud and water.

The Effect of Tissue Disintegration on the Determination of Liver Catalase Activity. T. E. Dickinson and R. W. Begg, Biochemistry Dept., Dalhousie University, Halifax, N. S. (Read December 12, 1949). During the course of investigations it was observed that liver catalase activity was greater when rat liver was disintegrated in a Waring Blendor than when ground with sand in a mortar. Evidence was presented showing that the monomolecular reaction constant K became progressively greater as liver was (a) ground lightly in a mortar, (b) ground thoroughly and, (c) homogenized in the Waring Blendor, despite dilution to constant amounts of nitrogen and tyrosine in all cases.

Thymus Tumors in Rats. R. W. Begg, Biochemistry Dept., Dalhousie University, Halifax, N. S. (Read January 16, 1950). During investigation of the effect of testosterone propionate on rats two tumors of the thymus were noted. These proved to be reticulum cell sarcomas.

By an estimation of the alkaline phosphatase content it has been shown that there is a formation of new connective tissue during thymus involution caused by steroid hormones. The possibility that this new formation of connective tissue may go on to malignant transformation was discussed.

Effect of Reverberation on Speech Intelligibility. R. H. Bolt and A. D. MacDonald, Physics Dept., Dalhousie University, Halifax, N. S. (Read January 16, 1950). A general statistical theory is developed for the masking effect of reverberation on the intelligibility of words. Speech is considered a series of discrete pulses distributed statistically over a 30-db range in sound pressure level in a given frequency band. The articulation index is calculated as a function of reverberation time, using preliminary values of speech pulse lengths and spacings obtained from Visible Speech spectrograms. The percent articulation for words is then calculated from the articulation index and is compared with Knudsen's experimental values. The theoretical values agree precisely with the measured values at reverberation times less than two seconds and differ by less than 17 percent out to six seconds. The calculations are extended to include a combination of background noise and reverberation.

Some New Results on the Behaviour of the Gulf Stream. W. L. Ford and F. C. Fuglister, Naval Research Estalishment, Halifax, N. S. (Read January 16, 1950). This paper presents a description of the Gulf Stream system between Cape Hatteras and 60° W. Long. and a qualitative analysis of the water masses in its surface layer based on observations taken during the period November 15 to December 6 1948. The 'cold wall' edge of the Stream was explored for 1050 miles of its length. The meanderings of the stream and its tendency to develop large eddies are demonstrated. Surface current velocities are given for many points; flows in excess of 5.5 knots were found on several occasions.

A temperature-salinity analysis of the surface layer shows that four basic water types are involved in the system. These are Gulf Stream water itself, Sargasso water from the Sargasso Sea, slope water from that region between the Gulf Stream and the 100 fathom line and, lastly, shelf water which originates on the continental shelf. The occurrence and interplay of these water types is discussed. One noteworthy feature is that as the Gulf Stream flows eastward from Cape Hatteras it is modified by the addition of Sargasso water only. No evidence of the absorption of slope waters was found.

The Theoretical Computation of the Physical Properties of Simple Solids. W. J. Archibald, Physics Dept., Dalhousie University, Halifax, N. S. (Read February 13, 1950). Starting with the law of force between atoms an attempt is made to compute the thermodynamic functions for the solid state of simple substances such as argon, neon, etc. The methods of statistical mechanics are employed and the model of the solid state to which the calculations refer is that suggested by Einstein according to which each atom may be treated as an harmonic oscillator. The immediate objective of the paper is to deduce the equation of state.

A Brief Survey of the Theoretical Considerations Concerning the Resistance Experienced by Bodies of Various Shapes in Passing Through Fluids. A. W. Marris, Naval Research Establish-

ment, Halifax, N. S. (Read February 13, 1950). An account was given of the basic principles of the boundary layer theory, and the consequent derivation of the formulae for the drag exerted by fluids on a body passing through them. The range of conditions considered was from the classical Stokes theory up to Reynolds numbers of order $10.^5$ The dependence of the pressure drag and the viscous drag on the shape of the body was dealt with in some detail, and it was explained how the boundary layer equations can be used for approximate solutions when the exact ones are unattainable. In conclusion a brief account of empirical data was given.

The Use of a Bolometer as a Molecular Beam Detector. C. A. Reilly, Chemistry Dept., Dalhousie University, Halifax, N. S. (Read March 13, 1950). The central problem in any research using a molecular beam is that of detection. The adaption of a platinum strip bolometer cooled with liquid nitrogen to the detection of molecular beams was shown. The bolometer consists of two strips of platinum each about 30 m wide and 10 mm. long rolled from Wollaston wire of core diameter 0.0004 inches. These two strips form two arms of a Wheatstone bridge, the unbalance of which, due to the molecular beam falling on one strip is detected by a Perkin-Elmer D.C. Breaker Amplifier. This amplifier is linear and its output is taken as a measure of the molecular beam intensity. This system has been used successfully to detect beams of various molecules and also a beam of free methyl radicals.

A Further Experiment on the Addition of Radioactive Phosphorus to a Lake. F. R. Hayes, J. A. McCarter, M. L. Cameron, and D. A. Livingstone, Depts. of Biology and Biochemistry, Dalhousie University, Halifax, N. S. (Read April 3, 1950). In July, 1949, 1000 millicuries of radioactive phosphorus were added to Bluff Lake, in the quartzite-granite area west of Halifax. The lake is geologically primitive, has a volume of 11.5×10^4 cubic metres, and the water is unstratified. It thus provides a contrast to the lake studied during the previous summer. The added phosphorus was followed by means of periodic water, plant, and mud analyses for a month, and the rate of uptake studied. It appears that there is a continual exchange between water and mud at such a rate that a complete turnover of the water phosphorus occurs every ten days. The participating store of phosphorus in the mud is also continually released to the water, but at a slower rate, being totally exchanged every three months.

A Calibrating Instrument for Simulating the Temperature and Pressure Conditions in the Sea. J. R. Longard, Naval Research Halifax, N. S. (Read April 3, 1950). An instrument has been developed at the Naval Research Establishment to simulate in the laboratory conditions of temperature and pressure met with at sea. It was built specifically for the calibration of a bathythermograph, but is generally applicable to testing other oceanographic equipment. To aid in illustrating the method of operation a description of the bathythermograph and the more recently developed sea-sampler is given. In the calibration chamber temperatures of 30° to 90° F. can be obtained with an accuracy of 0.05° F. and pressures can be applied simulating depths to 900 ft. with an accuracy of 5 ft. and to 450 ft. with an accuracy of 2 ft. In performing a bathythermograph calibration certain known depths

and temperatures are traced on a smoked slide. The slide is then superimposed on an adjustable grid representing depth and temperature coordinates which upon being photographed gives the completed calibration grid.

Electrophoretic and Enzymic Analyses of the Pancreatic Juice of the Dog. G. M. Byrne, J. I. Phinney, M. Schachter and E. G. Young, Biochemistry Dept., Dalhousie University, Halifax, N. S. (Read May 9, 1950). Pure juice has been obtained by direct cannulation of the main pancreatic duct from dogs with permanent gastric and duodenal fistula. Chemical estimations have been made of the amylolytic, lipolytic and proteolytic activities of pancreatic juice secreted in response to various physiological and pharmacological stimuli. A portion of each sample has been subjected to electrophoretic analysis and fractionation in a Tiselius-Longsworth apparatus. The concentration of total protein has varied between 0.2 and 6 percent depending on the stimulus but it was usually between 1 and 3 percent in response to food. The electrophoretic pattern at pH 8.6 in barbiturate buffer has consistently shown six peaks, exclusive of the false boundary. The distribution has been relatively constant and independent of the nature of the stimulus. This appears to be true also of the enzymic activity of the juice.

Evidence has been obtained to identify the B boundary as associated with proteolytic activity and the F boundary with amyolytic activity. The former comprised approximately 30 per cent and the latter 10 percent of the proteins present. The A. boundary possessed a relatively high ionic mobility and comprised only about 2 percent of the total protein. D was the major component and accounted for about 40 percent. Components C, D and E have not yet been identified.

The Activity of Enzymes Extracted from Yeast Cells Exposed to Radiation from Radon. K. D. Stewart and J. G. Aldous, Dept. of Pharmacology, Dalhousie University, Halifax, N. S. (Read May 9, 1950). This is a supplementary study to the action of ultraviolet radiation upon the enzymes of the intact yeast cell. Differences between the actions of these two forms of radiation are reported and discussed.

A Cytological Study of the Ovotestis in Certain Pulmonate Gastropods. Anne H. G. Watts, Biology Dept., Dalhousie University, Halifax, N. S. (Read May 9, 1950). In this paper the ascorbic acid, mitochondria, and alkaline phosphatase content of normal developing germ cells is described. Deviations from the normal after experimental treatment, such as irradiation and exposure to low temperatures, are reported.

The Cytology of the Molluscan Cell. Muriel J. Ord, Biology Dept., Dalhousie University, Halifax, N. S. (Read May 9, 1950). The cytoplasmic and nuclear constituents have been studied in the cells of the ovotestis of certain land pulmonates, with particular reference to the changes from young indifferent cells to highly differentiated male and female germ cells. This work has been done in two parts; A—the golgi apparatus was studied from its first appearance in the young germ cells to the characteristic form in the spermatid and egg cells; B—a mitotic poison, B B^1 DichloroDiethyl Methylamine Hydrochloride, was used to find its effects on the young indifferent cells, and also on the more specialized male and female cells.

Bold figures indicate Parts

Aldous, J. G. The Anaerobic Decomposition of the Glycogen in Living Yeast Cells 1 19
Aldous, J. G. The Influence of Monoiodoacetic Acid Upon the Viability of Yeast Cells 2 75
Aldous, J. G. A Method for Studying the Specificity of Metabolic Inhibitors in Intact Cells 3 43
Aldous, J. G. and M. G. Whillians. A New Method for Measuring the Analgesic Power of Drugs in Human Subjects 3 42
Aldous, J. G. See Stewart, K. D. 4 58
Aldous, J. G. See Stewart, K. D. 4 62
Archibald, W. J. An Approximate Solution of the Differential Equation of the Ultracentrifuge 1 18
Archibald, W. J. The Magnetic Moment of the Nucleus 2 74
Archibald, W. J., The Theoretical Computation of the Physical Properties of Simple Solids 4 60
Archibald, W. J. See Guptil, W. E. 3 46

Barnard, K. N. Ship Corrosion in Sea Water as Detected by Potential Surveys 2 76
Begg, R. W. Chemical Estimation of Reducing Steroids in the Adrenal of the Rat 3 44
Begg. R. W. The Systemic Effects of Malignancy. ... 4 58
Begg, R. W. Thymus Tumors in Rats 4 59
Begg, R. W., T. E. Dickenson, and D. G. Withers. The Influence of Adrenal Cortical Extract of the Systemic Effects of Tumors in Rats 4 58
Begg, R. W., See Dickenson, T. E. 4 59
Bolt, R. H., and A. D. MacDonald. The Effect of Reverberation on Speech Intelligibility 4 66
Byrne, G. M., J. I. Phinney, M. Schachter and E. G. Young. Electrophoretic and Enzymic Analyses of the Pancreatic Juice of the Dog 4 62

Cameron, H. L. Glacial Geology of the Yarmouth-Pubnico Area 3 44
Cameron, M. L. See McCarter, J. A. 4 59
Cameron, M. L. See Hayes, F. R. 4 61
Campbell, Roberta B., and E. G. Young. The Iodine Content of Foods 2 75
Campbell, Roberta B. See Young, E. G. 1 18
Chasson, Leo P. The Resistance of Tomato Relatives and Hybrids to Certain Mycological and Entomological Pests 1 20
Coffin, C. C. The Determination of Ionic Transference Numbers and Complex Ionic Concentrations with Radioactive Isotopes 2 74
Coffin, C. C., F. R. Hayes, L. H. Jodrey and S. G. Whiteway. Exchange of Materials in a Lake as Studied by the Addition of Radioactive Phosphorus 3 42
Coffin, C. C. and B. L. Funt. A Method of Preparing and Concentrating Radioactive Phosphorus 1 18
Coffin, C. C. and J. J. Tingley. The Exchange of Ag^+ Ions Between Aqueous Solutions and Surfaces of Metallic Silver 3 45

Dickenson, T. E. and R. W. Begg. The Effect of Tissue Disintegration and the Determination of Liver Catalase Activity 4 59
Dickenson, T. E. See Begg, R. W. 4 58
Dunn, A. F. Propagation of Electrical Waves in a Conducting Medium 1 21
Dunn, A. F., See MacLellan, H. J. 1 19
Dyer, Frances E. See Dyer, W. J. 1 19
Dyer, W J. and Frances E. Dyer. Spoilage of Freshly Cut Fillets 1 19

Foran, M. R., V. E. Vaughan and Thora Reid. The Penetration into Maritime Masonry Structures.... 1 20

Ford, W. L. and F. C. Fuglister. Some New Results on the Behaviour of the Gulf Stream 4 60
Fuglister, F. C. See Ford, W. L. 4 60
Funt, B. L. See Coffin, C. C. 1 18

Gorham, Eville. The Vegetation of Eight Nova Scotian Lakes 1 19
Gorham, Eville. Some Effects of Temperature on the Development of the Salmon 1 20
Guptil, E. W., A. T. Stewart and W. J. Archibald. A New Method for Detecting Nuclear Magnetism ... 3 46

Hayes, F. R. and Coworkers. The Effect of Adding Basic Slag and Ammonium Nitrate to Lakes 2 76
Hayes, F. R., J. A. McCarter, M. L. Cameron and D. A. Livingstone. A Further Experiment of the Addition of Radioactive Phosphorus to a Lake 4 61
Hayes, F. R. See Coffin, C. C. 3 42
Hayes, F. R. See McCarter, J. A. 4 59

Jodrey, L. H. See Coffin, C. C. 3 42
Jodrey, L. H. See McCarter, J. A. 4 59

LeLacheur, R. M. A Stroboscopic Light Source 1 21
Livingstone, D. A. An Attempt to Poison Coarse Fish in A Lake While Leaving Trout Unharmed 3 44
Livingstone, D. A. See Hayes, F. R. 4 61
Longard, J. R. A Calibrating Instrument for Simulating the Temperature and Pressure Conditions in the Sea 4 61

Marris, A. W. A Brief Survey of the Theoretical Considerations Concerning the Resistance Experienced by Bodies of Various Shapes in Passing Through Fluids 4 60
MacDonald, A. D. See Bolt, R. H. 4 50

MacLellan, H. J. The Voltage Sensitivity of Two Galvanometers in Series 1 21
MacLellan, H. J. and A. F. Dunn. Modifications to a Recording Microphotometer 1 19
MacLeod, Ada V. and E. G. Young. A Nutritional Survey of Young Children in Halifax, N. S. 4 58
MacPherson, M. G. and E. G. Young. The Chemical Composition of Marine Algae 3 46
McCarter, J. A., F. R. Hayes, L. H. Jodrey and M. L. Cameron. Exchange of Materials in a Lake Studied by the Addition of Radioactive Phosphorus below the Thermocline 4 59
McCarter, J. A. See Hayes, G. R. 4 61
Milford, N. Qualitative Detection of Nitrate Esters... 2 77

Ord, Muriel J. The Cytology of the Molluscan Cell... 4 62
Ord, Muriel J. See Watts, Anne H. G. 3 44

Pattison, F. L. M. An Investigation of Pharmacologically-Active Flourine Compounds 2 75
Pattison, F. L. M. The Fluorophosphates. A New Type of War Gas 2 76
Phinney, J. I. See Byrne, G. M. 4 62
Phinney, J. I. See Young, E. G. 2 74

Reid, Thora. See Foran, M. R. 1 20
Reilly, C. A. The Use of a Bolometer as a Molecular Beam Detector 4 61
Rogers, D. H. The Phase Contrast Principle in Microscopy 3 47
Ryan, J. A. See Young, E. G. 4 46

Schachter, M. The Stimulating Action of Anaesthesia on Gastric Secretion 4 32
Schachter, M. Sensitization of the Gastric Glands to Histamine After Complete Vagotomy 3 46

Schachter, M. See Byrne, G. M. 4 62
Smith, Marjorie. Some effects of Temperature on the Embryonic Development of the Salmon, (*Salmo Salar*) 3 47
Snow, J. M. The Colorimetric Estimation of Fish Muscle Protein 1 21
Stewart, A. T. The Influence of Relaxation Times on Nuclear Paramagnetism 3 45
Stewart, A. T. See Guptil, E. W. 3 46
Setwart, K. D. and Aldous J. G. The Activity of Enzymes Extracted from Ultraviolet Irradiated Yeast Cells 4 58
Stewart, K. D. and Aldous, J. G. The Activity of Enzymes Extracted from Yeast Cells Exposed to Radiation from Radon 4 62

Tingley, J. J. See Coffiin C. C. 3 45

Vaughan, V. E. See Foran, M. R. 1 20

Watts, Anne H. G. A Cytological Study of the Ovotestis in Certain Pulmonate Gastropods 4 62
Watts, Anne H. G. and Muriel J. Ord. The Cytology of the Reproductive Organs of Certain Land Mollusca of Nova Scotia 3 44
Weld, C. B. Oil Globules in Lung Tissue 2 74
Weld, C. B. Heparin and Lipemia 3 43
Whillians, M. G. Sea Water as a Supplement to Fresh Water Rations 1 20
Whillians, M. G. See Aldous, J. G. 3 42
Whiteway, S. G. See Coffin, C. C. 3 42
Wilmot, Isabella. The Oxygen Consumption of Developing Eggs of Salmo Salar 2 77
Withers, D. G. See Begg, R. W. 4 58
Wylie, D. W. A Dynamical Model of Crystal Structure 3 47

Yates, Peter. The Reactions of Aromatic Dinitriles 2 77
Young, E. G. and Roberta B. Campbell. The Reaction of BB'dichlorodiethyl Sulphide with Proteins 1 18

Young, E. G. and J. I. Phinney. The Proteins of the Egg Yolk of the Atlantic Salmon..... 2 74
Young, E. G. and J. A. Ryan. The Alleged Synthesis of Protein from an Inorganic Medium in the Presence of Iron..... 3 46
Young, E. G. See Byrne, G. M..... 4 62
Young, E. G. See Campbell, Roberta B..... 2 75
Young, E. G. See MacLeod, Ada V..... 4 58
Young, E. G. See MacPherson, M. G..... 3 46